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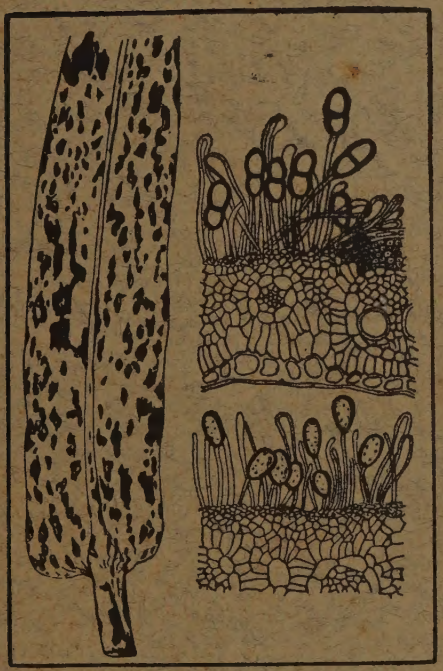

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THE MYXOMYCETES OF THE MUSSOORIE HILLS - II

K. S. Thind and H. S. Sohi

(Accepted for publication, December 13, 1955)

This paper is intended to record more Myxomycetes from the Mussoorie Hills as a part of the study of the Cryptogamic Flora of that region (Thind and Sohi, 1955). Seven species belonging to the order *Physarales* are described fully. Four species *Physarum viride* (Bull.) Pers., *Didymium minus* Morgan, *Didymium Iridis* (Ditm.) Fries (=*D. xanthopus* Ditm.), *Diderma deplanatum* Fries are new records in India. The classification as proposed by Martin, 1949, in North American Flora 1 : 1 (Myxomycetes) has been followed in the present study.

The writers are deeply indebted to Dr. G. W. Martin of the State University of Iowa, U.S.A. for help in the identification of some of these species, and Dr. P.N. Mehra, Head of the Panjab University Botany Department, for valuable criticism and encouragement. They are also thankful to Mr. Balram Khanna for making illustrations of fructifications.

Family: Physaraceae

8. *Physarum viride* (Bull.) Pers.

Fructifications sporangiate. *Sporangia* gregarious, or scattered, usually nodding, stipitate, yellowish brown to rusty, globose, 0.33-0.37 mm. in diameter. Stipe long, erect or bending, thick below and narrowed above, black in the lower portion, yellowish brown above, subulate, longitudinally grooved throughout, up to 2.4 mm. in height. *Hypothallus* present, not prominent. *Peridium* calcarious, encrusted by rounded, yellowish brown to deep brown crystals of lime, striated in the lowermost portion. *Dehiscence* by irregular rupturing of the peridium in the upper portion, its lower portion remaining persistent. *Columella* none. *Capillitium* abundant, a network of nodes and internodes. Nodes fewer, small, fusiform, yellow or orange, calcarious. Nodes are interconnected by abundant, slender, hyaline, thread-like, branching, noncalcarious internodes. Internodes are ultimately united with the peridium. *Spores* black in a mass, violaceous under the microscope, rounded, minutely echinulate, 7 - 8.7 μ in diameter. (Plate I, Fig 1, Text Fig. 1, a-b).

Collected on rotting wooden stumps, Kempty Falls, Mussoorie, September 17, 1952, 11. New record in India.

Family: Didymiaceae

9. *Didymium squamulosum* (Alb. & Schw.) Fr.

Fructifications sporangiate. *Sporangia* gregarious, rarely connate, stipitate, whitish due to calcarious deposits upon the peridium, globose or depressed globose, umbilicate below, 0.6-0.7mm. in diameter. Stipe

erect, whitish or cream coloured, dark brown at the base, calcarious, grooved, up to 0.55 mm. in height, i.e. about as long as the sporangium. *Hypothallus* well developed and prominent, ridged, rotate, dark brown, calcarious. *Peridium* thin, single, brown, encrusted with white stellate crystals of lime. *Dehiscence* occurs by rupturing of the upper portion of the peridium. The lower portion of the peridium remains persistent like a cup with a conspicuous columella in the centre. *Columella* prominent, reaching nearly the middle of the sporangium, brown and swollen into a sac at the top. *Capillitium* consists of numerous delicate, slender, light violaceous threads which are branched and united with each other. The threads rarely bear thick, violaceous nodular thickening. *Spores* black in a mass, dark violet brown under the microscope, globose, distinctly and profusely verrucose, warts also arranged in clusters, 7-10.5 μ in diameter. *Plasmodium* cream coloured, forming an irregular network over the substratum. (Plate I, Fig 2, Text Fig. 2, a-b).

Collected on dead leaves of *Quercus incana* and dead twigs of other plants, Tehri Road and several other localities in Mussoorie, September, 1951, 12. On dead leaves of *Viola* sp. and *Spiraea* sp., Jabber Khet, Mussoorie, September, 1951, 13.

10. *Didymium minus* Morgan.

Fructifications sporangiate. *Sporangia* gregarious, stipitate to subsessile, rarely sessile, whitish due to calcarious deposit on the peridium, depressed-globose, umbilicate below, 0.5 mm. in diameter. Stipe short, erect, black, up to 0.26 mm. in height, or almost lacking *Hypothallus* well developed, dark brown, rotate, membranous. *Peridium* brown, calcarious, encrusted by stellate, white crystals of lime. *Dehiscence* by rupture of the upper portion, lower portion remaining persistent. *Columella* prominent, reaching nearly the centre of the sporangium, brown, globose, apex convex. *Capillitium* abundant, composed of numerous, colorless, sparsely branched, threads which arise from the base of the columella. The capillitial threads run more or less straight and ultimately get attached to the peridium. *Spores* black in a mass, deep violet under the microscope, rounded, conspicuously and abundantly verrucose, 8.75-10.5 μ in diameter. (Plate 1, Fig. 3., Text Fig. 3, a-b).

Collected on living leaves and stems of *Spiraea* sp, The Park, Mussoorie, September, 1952, 14. New record in India.

11. *Didymium nigripes* (Link) Fr.

Fructifications sporangiate. *Sporangia* gregarious, stipitate, whitish due to calcarious deposit on the peridium, globose, umbilicate below, up to 0.5 mm. in diameter. Stipe long, erect, black below, deep brown above, slightly tapering upwards, furrowed, up to 2.5 mm. in height, i.e. about five times the length of the sporangia. *Hypothallus* well developed, dark brown, rotate. *Peridium* single, brown, whitish due to calcarious deposit which consists of white, stellate crystals of lime. *Dehiscence* by rupture of the upper portion of the peridium while its lower part remains persistent for some time. Ultimately almost whole of the peridium falls off leaving behind just a circular rim arround the stipe with conspicuous columella remaining

intact. *Colu & mella* prominent, reaching nearly the centre of the sporangium, brown, globose. *Capillitium* consists of slender, subhyaline to light brown, sparsely branched threads with occasional dark brown, nodular thickenings. *Spores* black in a mass, violaceous under the microscope, rounded, minutely verrucose, with clusters of warts at places, uniformly 8 μ in diameter. *Plasmodium* forming an orange network. (Plate I., Fig. 4., Text Fig. 4, a-c).

Collected on dead leaves of *Quercus incana* and other plants, several localities in Mussoorie, August, 1952, 15.

12. *Didymium Iridis* (Ditm.) Fries (=*D. xanthopus* Ditm.).

Fructifications sporangiate. *Sporangia* gregarious, short, stipitate to almost sessile, grayish white due to calcarious deposit on the peridium, globose, up to 0.6 mm. in diameter. Stipe short, erect, brown, translucent in mount, up to 0.35 mm. in height or almost lacking. *Hypothallus* well developed, dark brown, rotate. *Peridium* single, brown, looking whitish due to calcarious deposit which consists of white stellate crystals of lime. *Dehiscence* irregular. *Columella* white or pallid, globose, well developed. *Capillitium* consists of slender, violaceous, sparsely branched threads with deep coloured nodular thickening at places. *Spores* black in mass, violet under the microscope, rounded, minutely verrucose, with clusters of warts at places, 7 - 10 μ in diameter. (Plate I, Fig. 5, Text Fig. 5, a–b).

Collected on dead leaves of *Quercus incana* and living leaves of *Gerbera* sp, Burning Ghat, Mussoorie, September, 1951, 16. New record in India.

13. *Diderma effusum* (Schw.) Morg.

Fructifications white, plasmodiocarpous to sporangiate with all the intergradations. *Plasmodiocarps* flattened, depressed or broadly effused, arranged in long, continuous, reticulate or irregular masses, or separated into small curved, annular, or irregular bodies. *Sporangia* flattened, depressed-globose, sessile. *Peridium* double. Outer peridium thin, white, calcarious, shell like, fragile, disappearing early. Inner peridium well developed, grayish, disappears much later. When the outer peridium is broken the spores still lie enclosed within the inner peridium. Crustaceous matter of the outer peridium consists of rounded, whitish crystals of lime. *Dehiscence* irregular, generally by rupturing of the peridium at the top. *Columella* well developed and prominent, light brown, somewhat iridescent, running lengthwise in the plasmodiocarpous types but rounded and occupying a central position in the sporangiate types. Columella nearly occupies whole of the base and is just slightly raised into the cavity of the fructifications. *Capillitium* consists of numerous, slender, hyaline, sparsely branched, mostly straight, sometimes flexuous threads which are united with one another at the ends. *Spores* black in a mass, violaceous under the microscope, globose to subglobose or oval, inconspicuously verrucose. also with clusters of darker and larger but still minute warts, 7- 10 μ diameter. (Plate I, Fig. 6., Text Fig. 6, a-b).

Collected on dead leaves of *Quercus incana*, on dead as well as green leaves of *Rhododendron arboreum*, and on dead fronds of ferns, Jabber Khet, Mussoorie, September, 1952, 17.

14. *Diderma deplanatum* Fries

Fructifications sporangiate. *Sporangia* densely packed together or closely applied and adhering to one another and thus forming a thick sporangial crust over the substratum. Sporangia sessile, pinkish white, globose to irregular in shape due to mutual pressure, compressed or flattened and wrinkled at the top, up to 1 mm. in diameter, or slightly more by the longer side. *Hypothallus* inconspicuous. *Peridium* double. Outer peridium thick, white, shell-like, calcarious, calcarious matter consisting of rounded white crystals of lime, wrinkled. Inner peridium thin, brownish, non-calcarious, closely applied to the outer peridium. *Dehiscence* irregular, upper portion breaks off leaving a shallow cup below. *Columella* prominent globose or hemispherical, brown with a polished luster, convex at the top, occupies more than half of the sporangial cavity. *Capillitium* consists of numerous, slender, sparsely branched, colourless threads which run mostly straight but sometimes flexuous. The capillitial threads are united with one another at their apices and bear small, scattered thickenings. *Spores* black in mass, dark violet under the microscope, globose to subglobose or oval, conspicuously and profusely verrucose, 10.5-11.2 μ in diameter (Pl. I, Fig. 7., Text Fig. 7, a-b).

Collected on dead leaves and dead twigs of *Quercus incana* and other plants, and on dead remains of plants attached to a stone piece, Jabber Khet, Mussoorie, August, 1952, 18. New record in India.

The sporangia are rather small for the species but the thicker outer wall is characteristic and the pale capillitium and the spores are confirmatory of *D. deplalatum*.

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Amritsar.

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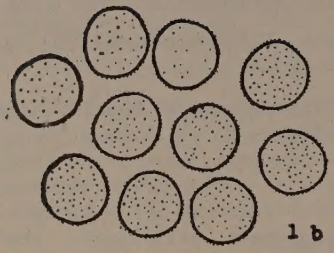

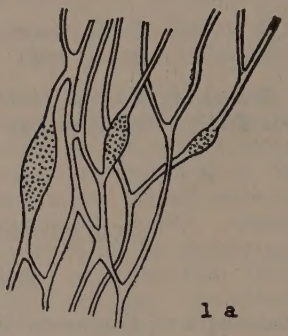

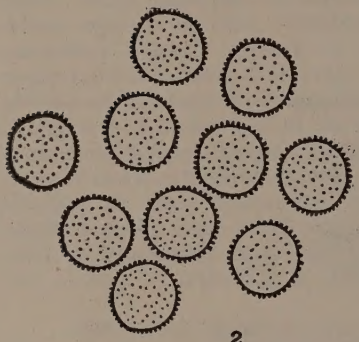

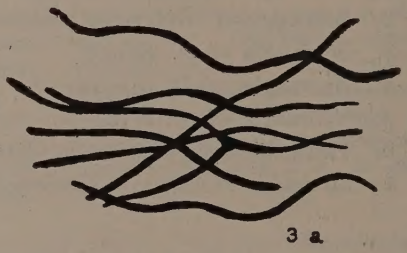

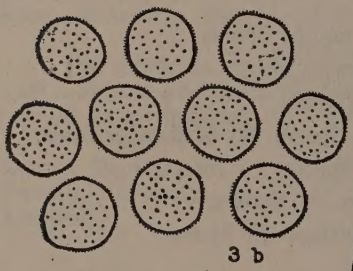

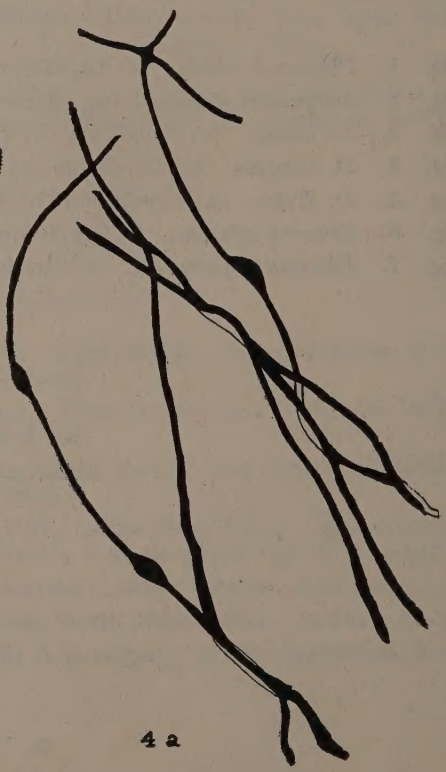

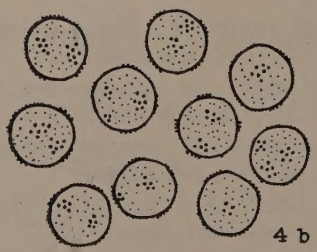

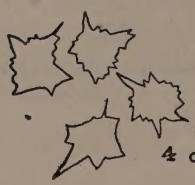

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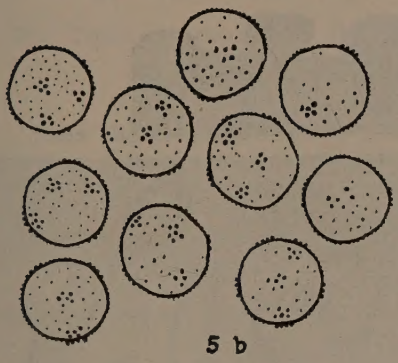
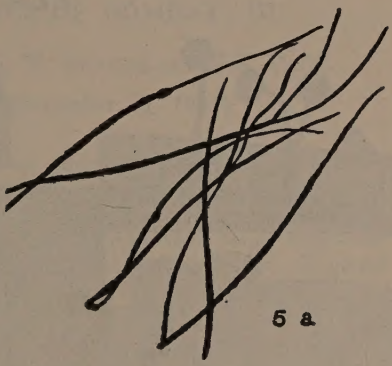
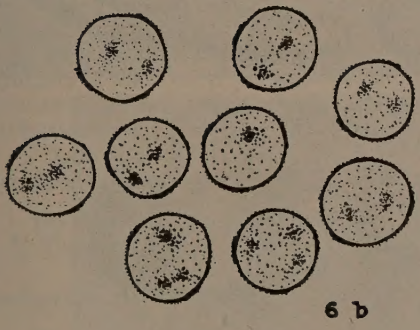
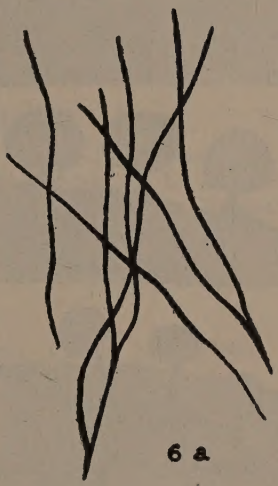
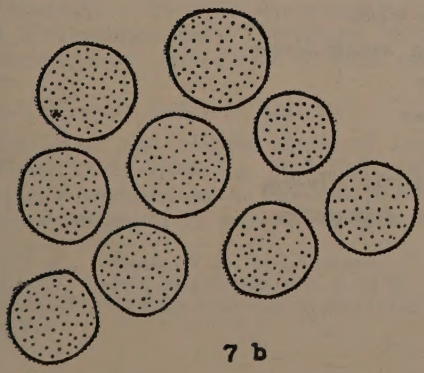










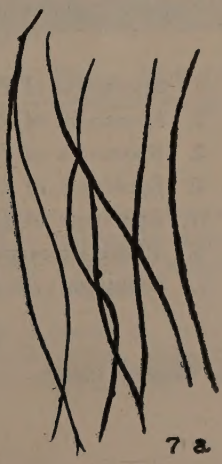
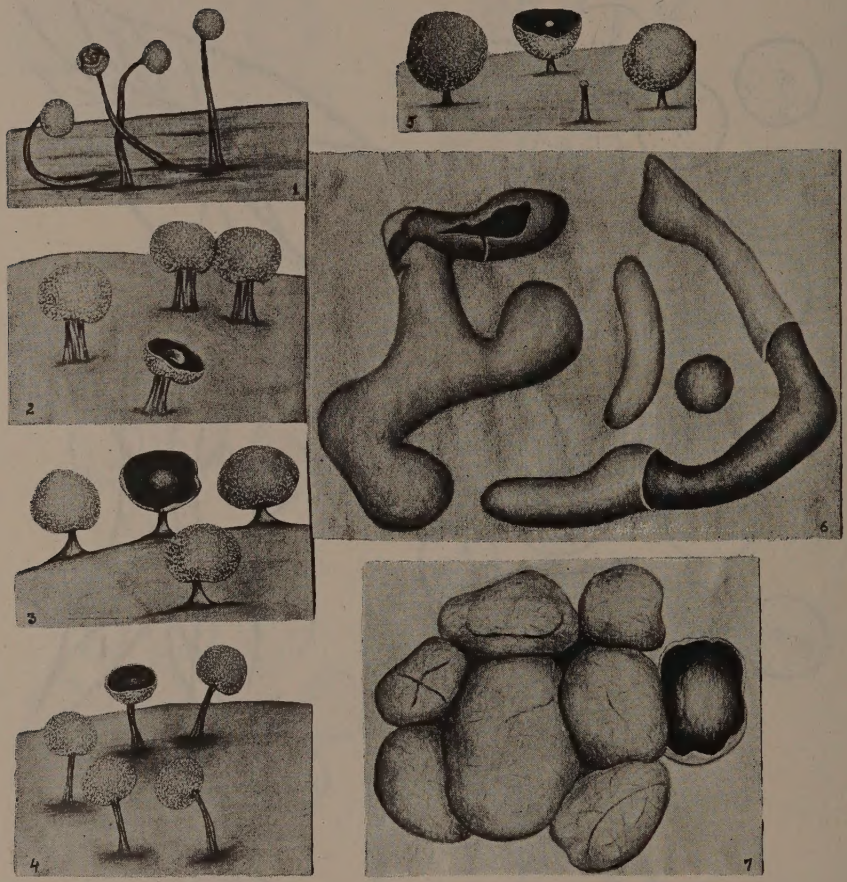


PLATE 1



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ADDITIONS TO THE FUNGI OF BOMBAY - III.

M. J. Thirumalachar, V. V. Bhatt, G. W. Dhande and M.K. Patel

(Accepted for publication, December 13, 1955)

Since the publication of the first two parts by Patel *et al*,* further collections of fungi have been made in different places in Bombay State. Some of the new records and new species of parasitic fungi for Bombay State are presented in this paper. Types of the new species have been deposited in the Herb. Crypt. Ind. Orient., New Delhi; Herb. C.M.I., Kew, England and Mycological Division, U.S.D.A., Beltsville, Md., U.S.A.

Physoderma aeschynomenes Thirum. & Whitehead

On stems of *Aeschynomene indica* L. Poona, 15-10-1954, leg. M. J. Thirumalachar. The fungus incites the formation of nodular galls on the submerged portions of the stem and is fairly well spread.

Physoderma echinochloae Thirum. & Whitehead

On leaves of *Echinochloa crusgalli* Beauv. 8-10-1954. Poona, leg. M. J, Thirumalachar. This is one of the commonest fungi in the marshy regions of Poona on *E. crusgalli* soon after the rainy season. In all small pools and puddles where the plants remain submerged for some period, the leaves show severe infection spots.

Physoderma cynodontis Pavgi & Thirum.

On leaves of *Cynodon dactylon* Pers., Pimpri, Poona, 14-10-1954, M. J. Thirumalachar.

Synchytrium borreriae Lacy

On leaves of *Spermacoce hispida* L., Ganeshkhind, Poona, 15-10-1954, leg. M. J. Thirumalachar.

Albugo evolvuli (Damle) Safee & Thirum. var *merremiae*

On shoots of *Merremia emarginata* Hall, Hadapsar, Poona, 6-10-1954 leg. M. J. Thirumalachar. The fungus incites systemic infection changing the prostrate habit of the host to erect condition.

Albugo mysorensis Safee & Thirum.

On leaves and axillary shoots of *Ipomoea hederacea* Jacy. Parvathi hills, Poona, 26-10-1954, leg. M. J. Thirumalachar. The sporangial stage of the fungus is produced on the leaves on pale yellow spots, while the oospores are formed separately in cerebriform galls in the axillary shoots.

*Patel M. K., Gokhale, V. P., and Kulkarni, N. B. (1951) Additions to fungi of Bombay-1. Indian Phytopathology, 4: 64-66. Patel, M. K., Payak, M, M, and Kulkarni, N, B, (1951) Additions to fungi of Bombay - II, Indian Phytopathology, 4: 71-73.

Protomycopsis smithiae Thirum., Bhatt, Patel and Dhande sp. nov.

Infection on leaflets appearing as black sooty patches, subspherical to polygonal, 4 to 6 mm. in diameter without causing hypertrophy. Resting spores intercellular, ovoid to globose, aggregated in large numbers, black in mass, deep olivaceous to reddish-brown, 25-31μ in diameter, wall 3.1 to 3.6μ thick, reddish-brown, irregularly folded to convolute to give warty appearance to the spore.

On leaflets of *Smithia sensitiva* Ait., Karjat, Bombay, leg. V.V. Bhatt and M. K. Patel.

Maculae fusco-fuliginosae, subsphaericae vel angulares 4-6 mm. in diam. Sporae quiescentes intercellulare ovoidea vel globosa obscuro olivacea vel rubro-brunneae 25-31μ in diam, episporis 3.1-3.6μ. crasso convoluto et rugoso.

Hab. in foliis *Smithia sensitivae.*

Smithia sensitiva is a small prostrate herb in moist places along the water channels. Some of the plants near Karjat, were found to be affected by a sooty spot disease, the infection appearing sparse and restricted to leaves near the ground. Microscopic examination revealed the intercellular hyphae and the numerous resting spores of the fungus distributed in the mesophyll tissue. The present record adds one more *Protomycopsis* species on another member of *Leguminosae.* The previous records from India are *Protomycopsis patelii* Pavgi & Thirum. on *Phaseolus radiatus* L., *P. crotalariae* Joshi on *Crotalaria triquetra* Dalz. and unpublished report of *P. sesbaniae* Gupta on *Sesbania aegyptica* Poir., The three species mentioned above differ from the fungus under study in spore size and sculpturing of the wall. In *P. patelii* and *P. crotalariae*, the wall of the resting spore is covered by cubical to blunt warts, while in *P. sesbaniae* the wall is reticulate. In *P. smithiae* on the other hand, the wall is covered with convolute folds comparable to the oospores of *Albugo candida.*

Taphrina rhomboidalis Syd.

On leaves of *Pteris biaurita*, Mahableshwar, Bombay, 4-4-1954, leg. M.J. Thirumalachar and A.J. Mix.

T. rhomboidalis has previously been reported from Assam on leaves of *Pteris quadriaurita*, and therefore *P. biaurita* is a new host record for the fungus.

Entyloma bidentis P. Henn.

On leaves of *Bidens pilosa* L. Mahableshwar, 15-3-1954, leg. M. J. Thirumalachar.

Melanotaenium spermacoces Thirum., Patel, Dhande & Bhatt sp. nov.

Infection appearing on leaves as dull grey diffuse spots, circular, without inciting malformation of the host. Chlamydospores scattered in the intercellular spaces of mesophyll, deep olivaceous-brown, 7.5-12.5μ in

diameter with a mean of 10 μ., with a small hyphal appendage attached to one end. Germination unknown.

On leaves of *Spermacoce hispida*. L. Ambernath, Bombay, 15-8-1954, leg. M. K. Patel, G. W. Dhande and V.V. Bhatt.

Maculae fuliginosae, hypophyllae, indefinitae circularis vel angularae. Sporae in mesophyllo evolutae, laxe aggregatae, obscure olivaceae 7.5–12.5μ in diam. plerumque ca. 10μ. diam. mentientes, episporio crassiusculo levi, interdum appendicula hyphae. Germinationis ignota.

Hab. in foliis *Spermacoce hispidae*.

This interesting smut was collected in a large patch of plants growing at Ambernath. Infection is confined mostly to lower leaves appearing as dull grey circular spots. The chlamydospores are developed sparsely at the end of the hyphal branches. A small remnant of the hyphae remains persistant appearing as a small hyphal appendage. Comparative studies with others species of *Melanotaenium* on dicots including the recently described *M. euphorbiae* (Lenz) Whitehead & Thirum. show that this species is different. The spores are loosely grouped and very small in size.

Tilletia eleusines Syd.

In ovaries of *Dactylotaenium aegypticum* Beauv., Lonavla, 10-8-1954, leg. M. J. Thirumalachar.

Tilletia pulcherrima Ell. & Gall. var. *brachiariae* Pavgi & Thirum.

In ovaries of *Brachiaria distachya* Haines, Poona, 8-11-1954, leg. M. J. Thirumalachar. This smut species has previously been reported only from Banaras in U.P.

Doassansia hygrophilae Thirum,

On leaves of *Hygrophila longifolia* Kurr., Khandala, 10-10-1954, leg. M. J. Thirumalachar. This smut is well distributed in all the marshy regions in Bombay State.

Sorosporium turneri McAlpine

In ovaries of *Eragrostiella bifaria*, Pimpri, Poona, 10-8-1954, leg. M. J. Thirumalachar. The smutted ovaries are very inconspicuous and often are covered with the sooty coating of *Helminthosporium ravenelii* which occurs on the spikelets. The smut has previously been recorded for India by Pavgi & Thirumalachar from U.P.

Ustilago sparsa Underwood

In ovaries of *Dactylotaenium aegypticum*, Pimpri, Poona, 8-11-1954, leg. M. J. Thirumalachar.

Sphacelotheca erythraeensis (Syd.) Clinton

On the inflorescence of *Manisuris granularis* Sw., Pimpri, Poona.

Sphacelotheca iseilematis (Syd. & Butl.) Mundkur & Thirum.

In spikelets of *Iseilema laxum* Hack, Pimpri, Poona, 26–9–1954, leg. M. J. Thirumalachar.

Acervulopsora ichnocarpi (Barcl.) Thirum.

On leaves of *Ichnocarpus frutescens* Br., Khandala, 20–10–1954, leg. M. J. Thirumalachar.

Catenulopsora flacourtiae Mundkur & Thirum.

On leaves of *Flacourtia cataphracta* Wall. and *F. septiaria* Roxb.

Masseeella breyniae Thirum.

On leaves of *Breynia rhamnoides* Muell., Khandala, 20–10–1954, leg. M. J. Thirumalachar.

Masseeella narasimhanii Thirum.

On leaves of *Flueggea leucopyrus* Willd., Pimpri, Poona, 28–11–1954, leg. M. J. Thirumalachar.

Pharagmidiella heterophragmae Thirum. & Mundkur

On leaves of *Heterophragma roxburghii* DC., Khandala, 20–10–1954, leg. M. J. Thirumalachar.

Olivea colebrookiae (Barcl.) Thirum. & Yadav

On leaves of *Colebrookia oppositifolia* Sm., Khandala, 10–10–1954, Leg. M. J. Thirumalachar.

Ravenelia Berkleyii Mundkur & Thirum.

On leaves and stems of *Cassia absus* L., Pimpri, Poona, 8–10–1954, leg. M. J. Thirumalachar.

Ravenelia breyniae-patensis Mundkur & Thirum.

On leaves of *Breynia patensis* Benth., Khandala, 20–10–1954, leg. M. J. Thirumalachar.

Dasturella divina Mundkur & Kheswalla

On shoots of *Randia uliginosa* DC., Khandala, 20–10–1954, leg. M. J. Thirumalachar. The aecial stage of this giant bamboo rust was seen in abundance in the vicinity of bamboo clumps affected by *D. divina*. The aecial stage incites the systemic infection of the axillary shoots forming witches broom.

Kordyana boswelliae Thirum., Patel, Dhande & Bhatt Sp. nov.

Infection on upper leaf surface circular or irregular, appearing as reddish-brown spots and deep rusty brown on lower surface, surrounded

by a sulphur–yellow zone, often coalescent to form large patches, 5–15 mm. in diameter. Fruiting bodies hypophyllous, hyphae grouped in substomal space, basidia protruding out in a radiating cluster, cylindric, hyaline, 30–35 x 4–6μ., bearing apically 2 basidiospores on short sterigmata. Basidiospores hyaline, thin–walled, asymmetric, 10.5–14.5 x 5.5–8.5μ., germinating immediately.

On leaves of *Boswellia* sp. Katraj, Bombay, 12–8–1954, leg. M. J. Thirumalachar and M. K. Patel.

Maculae circulares vel irregulares, 5–15 mm. in diam. rubro-brunneae. Zonula flava cinctae, saepe coalescentes. Caespituli plerumque hypophylli, basidia evoluta substomatibus innate faciculatim erumpentia. Superne divergentie, cylindriea, hyalinae 30–35 x 4–6μ. Basidiosporae hyalinae, asymmetricae 10. 5–14 x 5.5–8.5μ. Statem germinantes.

Hab. in foliis *Boswellia* sp.

Five species of *Kodlyana* are known at present and most of them are parasitic on members of the Commelinaceae. The fungus under study inciting orange yellow rusty spots is different from the other species previously reported.

Septoria lycopersici Speg.

On leaves of *Lycopersicum esculentum* Mill., College Farm, Poona, 25–11–1954, leg. M. J. Thirumalachar.

Cylindrosporium Koenigii Thirum.

On leaves of *Murraya koenigi* Spreng., Poona, 20–12–1954, leg. M.J. Thirumalachar.

Cylindrosporium mappiae Thirum. & Narasimhan

On leaves of *Mappia foetida* Miers., Mahableshwar, 4–4–1954, leg. M. J. Thirumalachar.

Ramularia tinosporae Thirum. & Lacy

On *Tinospora cordifolia* Miers., Karjat, Bombay, 6–11–1954, leg. M. J. Thirumalachar.

Cercospora pavetticola Thirum. & Govindu

On leaves of *Pavetta tomentosa* Roxb., Khandala, 20–10–1954, leg. M. J. Thirumalachar.

Cercospora boerhaavicola Thirum. & Govindu

On leaves of *Boerhaavia diffusa* L., Chaturshringi, Poona, 12–6–1954, Leg. M. J. Thirumalachar.

Cercospora tridacis-procumbentis Govindu & Thirum.

On leaves of *Tridax procumbens*, L., Chaturshringi, Poona, 12-6-1954, leg. M .J. Thirumalachar.

Cercospora carbonacea Miles

On leaves of *Dioscorea* sp. Khopoli, Poona, 12-10-1954, leg. M . J. Thirumalachar.

Cercospora patelii Thirum. & Govindu

Sy. *Cercosporella leucadis* Uppal *et al.*

On leaves of *Leucas stelligera*, Wall., Mahableshwar, leg. M. J. Thirumalachar.

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CONTROL OF THE BLAST DISEASE OF RICE WITH SPRAY FUNGICIDES

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Introduction

The Blast disease of rice, caused by *Piricularia oryzae* Cav., causes a considerable amount of loss in yield in many places in India. Under experimental conditions at the Central Rice Research Institute, Cuttack, 18 to 43 per cent loss in yield has been recorded during the years from 1950 to 1954 in a susceptible variety.

Control of the disease by spray fungicides has been attempted by several workers. Metcalf (1906) claimed that blast was controlled to a great extent by spraying Bordeaux Mixture of 5–5–50 strength just before the emergence of earheads. According to Lin (1936) spraying the crop twice during the season with 0.5 per cent Bordeaux Mixture gave a satisfactory control of the disease. Vaheeduddin (1953) obtained an increase in yield of 45 per cent as a result of a single spraying of Perenox (0.35 per cent) on the affected crop. Hashioka (1950) reported, on the contrary, that spraying with Bordeaux Mixture had little effect in controlling blast.

The object of the investigation reported here was to find out if blast could be effectively controlled by spray fungicides and if so, what were the conditions under which spraying would be economical. The following studies were taken up for this purpose.

(1) The relative efficacy of fungicides in controlling blast.

(2) The most effective period of spraying with reference to different stages of infection.

(3) The efficacy of low–volume spraying against normal spraying.

(4) The relative costs of spraying.

Materials and Methods

Four field experiments in all were conducted during the years 1951 to 1954. A very susceptible variety, Co. 13, was used and the predisposing factors, such as late planting and application of ammonium sulphate, were provided to induce heavy incidence of blast (Padmanabhan *et al*, 1953; Ganguly *et al*, 1954). The fungicides used in different experiments were "Bordeaux Mixture" 5–5–50, "Bordeaux Mixture" 2.5–3.5–50, "Perenox" 0.3 per cent, "Coppesan" 0.5 per cent, "Dithane z–78" 0.2 per cent and "Wetcol-15" 0.3 per cent. The spraying equipment consisted of ordinary or pre-

ssure-retaining knapsack sprayers fitted with ordinary nozzles for normal spraying at the rate of 75–100 gallons per acre and pressure-retaining knapsack sprayers fitted with "Tee-jet" type low-volume nozzles for low-volume spraying at 20 gallons per acre. Observation on leaf infection was recorded prior to spraying. Individual plants in random sample units of 2 ft. x 2 ft. were scored for leaf infection with reference to a standard chart with scores ranging from 1-8, denoting no infection to total destruction of leaf. As expected, leaf infection was uniform and fairly severe in all plots. Similar observation on neck infection was taken at the time of harvest. On an average, nearly 6 per cent of the total population was observed both for leaf and neck infections. Yields of individual plots were recorded. The efficacy of spraying was judged by the increase in yield and reduction in neck infection.

Result

1) *Efficacy of different fungicides in controlling blast*::

The comparative efficacy of different fungicides with Bordeaux Mixture of 5–5–50 strength as standard was tested in two experiments. Details of the experiments and the results are presented in Tables 1 and 2.

Table 1

The relative efficacy of Bordeaux Mixture 5–5–50, Bordeaux Mixture 2.5–3.5–50 and Perenox 0.3 per cent on the incidence of blast and yield of rice.

Treatments.	(1) 4 sprayings of Bordeaux 5–5–50 (2) 4 sprayings of Bordeaux 2.5–3.5–50 (3) 4 sprayings of Perenox 0.3 per cent. (4) Control (Unsprayed).
Variety	Co. 13.
Layout	Randomised Block.
Replications	12
Area of unit plot	40 ft. x 12.5 ft.
Date of planting	12–8–51.
Manuring	Ammonium sulphate at 40 lb. N per acre (all plots).
Dates of spraying	15–9–51, 27–9–51, 7–10–51 and 18–10–51.

Treatments	(1)	(2)	(3)	(4)	S.E.	C.D. (0.5%)
Percentage neck infection	18.1	21.1	22.9	36.9		
(Angular value)	(25.15)	(27.34)	(28.56)	(37.41)	(1.14)	(4.37)
Mean yield per acre in lb.	1365	1235	1194	879	63.7	208.5

It may be seen from Table 1 that the three fungicidal treatments were associated with significantly lower percentage of neck infection and

significantly higher yields than those in the unsprayed control plots. Differences among fungicidal treatments were not significant.

TABLE 2

The relative efficacy of Bordeaux Mixture 5–5–50, Perenox 0.3 per cent, Coppesan 0.5 per cent, Wetcol 0.3 per cent and Dithane 0.2 per cent on the incidence of blast and yield of rice.

Treatments.	(1) 4 sprayings of Bordeaux 5–5–50 (2) 4 sprayings of Perenox 0.3 per cent. (3) 4 sprayings of Coppesan 0.5 per cent. (4) 4 sprayings of Wetcol 0.3 per cent. (5) 4 sprayings of Dithane 0.2 per cent. (6) Control (Unsprayed).
Variety.	Co. 13.
Layout.	Randomised Block
Replications.	12
Area of unit plot.	40 ft. x 12.5 ft.
Date of planting.	29-8-53
Manuring.	Ammonium sulphate at 60 lb. N per acre in all plots.
Dates of spraying.	15–9–53, 28–9–53, 22–10–53 and 29–10–53 .

Treatments.	(1)	(2)	(3)	(4)	(5)	(6)	S.E.	C.D. (0.5%)
Percentage neck infection	26.9	26.7	20.4	33.4	33.9	31.5		
(Angular value)	(31.10)	(31.10)	(26.67)	(35.23)	(35.53)	(34.00)	(0.99)	(2.85)
Mean yield per acre in lb.	835	817	965	677	751	555	49.5	141.5

It may be seen from Table 2 that three of the fungicidal treatments, i.e., Coppesan, Bordeaux Mixture 5–5–50 and Perenox were associated with a significantly lower percentage of neck infection than that in the control. As regards yield, all the fungicides, excepting Wetcol, gave significantly higher yields than those obtained from the control plots. Dithane at the level used was significantly inferior to Coppesan. Amongst the remaining fungicides, Coppesan, Bordeaux Mixture and Perenox, the differences in yield were not significant.

(2) *Effect of time and number of sprayings on blast incidence and yield of rice.*

An experiment was conducted with Bordeaux Mixture of 5–5–50 strength to find out the most effective period and number of sprayings for preventing the loss in yield due to blast. Details of the experiment and the results are presented in Table 3.

TABLE 3

Treatments	(1) 4 sprayings, 2 before and 2 after flowering. (2) 2 sprayings, 1 before and 1 after flowerlng. (3) 2 sprayings, both before flowering. (4) 2 sprayings, both after flowering. (5) Control (Unsprayed).
Variety	Co. 13.
Layout	Randomised Block.
Replications	8
Size of unit plot.	29 ft. x 9.75 ft.
Date of planting.	21–8–1953.
Manuring.	60 lb. N. per acre as ammonium sulphate.
Spraying.	On different dates between 4–9–53 and 30–10–53.

Treatments.	(1)	(2)	(3)	(4)	(5)	S.E.	C.D. (0.5%)
Percentage neck infection.	21.90	28.32	34.95	25.19	32.67		
(Angular value)	(27.37)	(31.73)	(35.85)	(27.29)	(34.57)	(2.13)	(4.31)
Mean yield per acre in lb.	1089	976	926	1013	897	94.3	190.8

Analysis of data in the above experiment showed that the percentage of neck infection in two of the treatments, 4 sprayings and 2 sprayings after flowering, was significantly less than that in the control. As regards yield, there was a significant increase in yield over control, only under 4 sprayings, while yield under 2 sprayings after flowering was next in order but below the level of significance.

(3) *Effectiveness of low–volume spraynig.*

An experiment was conducted to determine the effectiveness of low-volume spraying in controlling blast and to compare its efficacy with normal spraying. Details of the experiment and results are presented in Table 4.

TABLE 4

Treatments.	(1) 4 sprayings, 2 before and 2 after flowering with pressure-retaining knapsack sprayers and ordinary nozzles. Spray fluid used at the rate of 100 gallons per acre. (2) 4 sprayings, 2 before and 2 after flowering with pressure–retaining knapsack sprayers and low–volume nozzles. Spray fluid used at the rate of 20 gallons per acre. (3) Control (Unsprayed).
Variety.	Co. 13.
Layout.	Randomised block with 9 replications.

Size of unit plot. 93 ft. x 11.5 ft.
Date of sowing. 3–7–54.
Date of planting. 5–8–54.
Dates of spraying. 10–9–54, 23–9–54, 30–9–54, and 9–10–54.
Fungicide used. Coppesan 0.5 per cent.
Manures applied. Green manure at 40 lb. N per acre at the time of puddling and ammonium sulphate at the rate of 40 lb. N per acre on 4–9–54.

Treatments.	(1)	(2)	(3)	S.E.	C.D. (0.5%)
Percentage neck infection.	4.30	11.20	29.60		
(Angular value).	(11.78)	(18.45)	(32.39)	(2.59)	(7.78)
Mean yield per acre in lb.	1897	1821	1470	41.90	125.40

It may be seen from Table 4 that both normal and low-volume sprayings gave significantly higher yields and lower percentage of neck infection than those in the control plots. The two treatments were not significantly different from each other both as regards yield and neck infection. It is thus apparent that spraying with the help of low volume nozzles at the rate of only 20 gallons of spray fluid per acre is as efficient as spraying with ordinary nozzles at 100 gallons per acre in controlling blast infection and increasing the yield of rice.

(4) *Cost of spraying*

The cost of chemicals in the different spraying experiments calculated at current market rates and the corresponding increase in yield with their values are presented in Table 5.

It may be seen from Table 5 that low-volume spraying gave an adequate economic return. When spraying was carried out with ordinary nozzles, an economic return could be obtained only when the concentration of the fungicide in the spray fluid was reduced.

Discussion

Blast is a serious disease of rice in India and causes a considerable loss in yield every year. It is particularly important, since its severity increases with increased application of nitrogenous manures, the latter being an essential factor for stepping up rice production in this country. Control of blast, like control of most other plant diseases, could be best achieved by growing resistant varieties. But as long as suitable resistant strains are not available, it is necessary to adopt direct control measures for minimising the loss, as far as possible.

Previous work has shown that blast could be effectively controlled by spraying and an increased yield could be obtained thereby. This has

TABLE 5

Year.	Chemical.	No. of sprayings	Cost of chemical per acre	Average increase in yield in lb. per acre	Value of increased yield at Rs. 7/- per maund (82 lb.)	Remarks
1951–52.	Bordeaux (5–5–50)	4	Rs. 38 12 0	484	Rs. 41 0 0	A little more than an acre of crop can be covered in 8 hours working day by one labourer. Therefore the incidental labour charges for spraying 4 to 5 times in a season will be approximately Rs. 5/- per acre.
1951–52.	Bordeaux (2.5–3.5–50)	4	Rs. 20 0 0	353	Rs. 30 0 0	
1951–52.	Perenox (0.3%)	4	Rs. 42 0 0	312	Rs. 26 8 0	
1953–54.	Bordeaux (5–5–50)	4	Rs. 38 12 0	279	Rs. 23 12 0	
1953–54.	Perenox (0.3%)	4	Rs. 42 0 0	263	Rs. 22 0 0	
1953–54.	Bordeaux (5–5–50)	2	Rs. 19 6 0	116	Rs. 9 14 0	Two sprayings after flowering.
1953–54.	Coppesan (0.5%)	4	Rs. 50 0 0	410	Rs. 35 0 0	
1954–55.	Coppesan (0.5%)	4	Rs. 50 0 0	427	Rs. 36 12 0	
1954–55.	Coppesan (0.5%)	4	Rs. 10 0 0	351	Rs. 30 4 0	Low–volume spraying.

been confirmed by the present study. No information was, however, available as to the conditions under which spraying would be economical and could be recommended for general application under Indian conditions. The present study provided some information on this point.

It was found that four sprayings in a season brought about a significant reduction in neck infection and a significant increase in yield of rice. Complete control of the disease could not, however, be effected even by 4 sprayings. Excepting Wetcol, all the fungicides used in the present study were more or less equally effective. Owing to the rather high price of fungicides in India, the cost of fungicides alone in 4 sprayings, was Rs. 38/12/- to Rs. 50/- per acre. This was either uneconomical or just compensated by the increased yield. Thus inspite of its fairly high efficacy spraying with a fungicide 4 times in a season cannot be recommended because of the high cost involved. It was, therefore, necessary to reduce the cost of spraying by any of the means such as reducing the concentration of fungicide in the spray fluid, reducing the quantity of spray fluid per acre and finding out the best time and minimum number of sprayings required without in any way sacrificing the effectiveness of the spray fluid.

The present investigation has shown that spraying at the rate of only 20 gallons per acre by the use of low-volume nozzles in place of oridinary nozzles was as effective as spraying at the rate of 100 gallons per acre using ordinary nozzles. Thus by adopting low-volume spraying, the cost of chemicals was reduced to 1/5th of normal spraying and a return of Rs. Rs. 20/4/- per acre over the cost of spraying was obtained. Secondly, by reducing the strength of Bordeaux Mixture to 2.5–3.5–50, a return of Rs. 10/- could be obtained. Thirdly, though evidence was not conclusive, it seemed that two sprayings given after flowering of the crop might be enough to control the disease to a large extent.

Summary

Four sprayings either of Bordeaux Mixture 5:5:50 and 2.5:3.5:50; Coppesan 0.5%; Pernox 0.3%; and Dithane 0.2% were able to reduce the neck infection and increase the yield of rice considerably. An increase in the yield to the extent of 74 per cent over the control has been recorded in a very susceptible variety. Differences amongst the fungicides tried were not always significant.

Spraying twice with Bordeaux Mixture 5:5:50 after flowering of the crop was also effective in controlling blast.

Spraying with low-volume nozzles reduced the cost further. Low-volume spraying at the rate of 20 gallons of the spray fluid per acre was as effective as normal spraying at 100 gallons per acre with ordinary nozzles. The cost of chemicals in 4 sprayings with low-volume nozzles was Rs. 10/- per acre against an increased yield worth Rs. 30/4/- per acre.

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TYLOSE FORMATION IN TEA.

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Introduction.

Tea plants, growing in certain types of soil in North-east India, suffer in varying degrees from shortage of water during the dry months of the winter and early spring. When droughty spells are of short duration, the growth of the plants is arrested only for the time and it is soon resumed after these spells are broken by rain. If, however, the rain is late in coming, the plants undergo diurnal wilting and the foliage looks yellowish; gradually the leaf blade develops reddish-brown patches between the veins and finally permanent wilting of the foliage sets in. This condition is often followed by die-back of the branches and ultimate death of the whole plant.

Microscopical examination of the different organs of tea plants subjected to such conditions shows that tissues are not appreciably affected during the earlier phases, i.e., up to the diurnal wilting stage. When the effect of water shortage manifests itself in dying back of the stems after permanent wilting of the foliage, the most important change in the tissues is evidenced by extensive plugging of the xylem vessels, particularly of the stem, by the formation of tyloses.

In the tea plant tyloses have been found to grow into the vessels, only from the adjoining medullary ray cells which are multiseriate and situated at very close intervals. In their initial stages of growth they appear as small arcs formed by bulging of the thin membrane which closes the pit. At first these arcs project a little above the pits, gradually assuming a spherical shape until the opposite wall of the vessel is reached when they become elongated or flattened. The canals connecting the tyloses with the ray cells are illustrated in Pl. 1 Fig. 1. In tea, tyloses are at first thin walled, membranous, hyaline, looking like soap bubbles. In their early, spherical stage they appear to be filled with protoplasmic substances. By the time the tyloses become full grown (i.e., the opposite wall of the vessel is reached) and sometimes a little before that, most of them assume a light yellowish-brown colour. Occasionally the walls of some tyloses appear to become lignified.

In the initial stage there may be a few small tyloses in a vessel (Pl. 1, Figs, 2 & 3), but later on it may be completely occluded by the formation of a large number of them (Pl. 1, Fig. 4). At this later stage their shape varies considerably.

Gerry (1914) made an extensive study of tylose formation in many native North American woods and observed it to be a characteristic feature of the normal, uninjured wood of many families of trees. She found tyloses in the sapwood of all species in which they occurred in the heart-

wood. She reported the contents of tyloses to be the same as those of the parenchyma cells; starch was stated to be common and resin, calcium crystals and gums were also observed. Struckmeyer, Beckman, Kuntz and Riker (1954) stated that in some instances normal pits were differentiated in the tylose walls; the nucleus of the ray cell often migrated into a tylose and that starch grains were present occasionally.

Chattaway (1949) made an extensive survey of the development of tyloses and secretion of gums in the wood of over 1100 genera. She suggests that increased activity of living ray cells bordering on air filled vessels induces the formation of tyloses or the secretion of gums depending on the size of the pits.

Beckman, Kuntz, Riker and Berbee (1953) in their study of Oak wilt occurring as a result of infection by *Chalara quercina*, Henry (*Endoconidiophora fagacearum*, Bretz) have found that plugging of the water conducting tissues by tylose formation was the cause of wilting but tylose formation itself was a response of the host plant to some toxic action of the pathogen. Later Struckmeyer, Beckman, Kuntz and Riker (1954) reported that development of foliage wilt followed extensive vascular plugging by the formation of tyloses and gum and that it appeared to result from insufficient water rather than from toxicity of the organism.

Gerry (1914) further observed that tyloses are formed from the parenchymatous cells bordering on empty vessels. Wounding of trees through cuts and bruises or the breaking off of branches tended to stimulate tylose formation, and that tyloses could develop in felled logs where the parenchyma cells were still living.

Material and Method

The writer reports the observations made on a large number of tea plants extending over many years. During this period tea plants affected by drought, primary and secondary fungous diseases, and parasitic plants were examined. In addition, observations were made on young plants subjected to wilting in the laboratory by withholding the supply of water and on tea plants wounded in various ways.

Sections of woody materials about 10 – 20μ thick were made with a microtome; free-hand sections were made of soft materials such as young succulent stems or the mid-rib of leaves.

Aqueous solutions of safranin and methyl violet were used for general staining, chlorzinc iodine for lignification test, potassium iodide-iodine (0.3%) for starch and cotton blue B in lacto-phenol and aqueous methyl violet for fungal elements. Glycerine and Canada balsam were used for temporary and permanent mounts respectively.

Results

Tylose formation not observed in healthy tea plants

Tea plants which are grown for the production of young shoots used

in the manufacture of commerical tea are subjected to various pruning operations. The writer has examined a large number of such plants, varying in age from 3 to 40 years, but has never observed tyloses in sections of woody tissues of the uninjured parts. Tyloses have not been observed in young, uninjured plants up to 3 years in age. Plate 1, fig. 5 shows tylose free vessels in a 2 year old normal tea stem.

Tylose formation in relation to water shortage

During his examination of hundreds of tea plants killed by drought or shortage of water caused by certain slow acting fungi, the writer has observed varying degrees of tylose formation in the xylem vessels.

In case of drought affected tea it was at first believed that plugging of the vessels by tylose formation preceded permanent wilting of the foliage since the two things were associated. Subsequent observations on young plants subjected to water shortage under laboratory conditions showed tylose formation to take place only to a small extent during the wilting period. Extensive plugging by tyloses occured only when the stems started to die-back, usually a few weeks after permanent wilting and shedding of the wilted foliage. When the stems started dying back, tyloses were formed profusely in the green tissues to some distance below the dead parts.

Two lots, each of a dozen healthy, 7 month and 3 year old potted plants were grown under laboratory conditions and subjected to water shortage by cutting off the supply of water. Diurnal wilting started from the fourth day and continued for 9 - 11 days after which the foliage wilted permanently and dried up but the stems were apparently green and healthy.

Four plants from each of the above two lots were examined between 7 and 9 days of diurnal wilting and an equal number after permanent wilting of the foliage but before die-back of the stems took place. All the 7 month old plants and one three year old plant were completely free from tyloses. The remaining 7 out of the 8 three year old plants showed a few tyloses in the innermost region of the wood at the collar which was 1-1¼ inches in diameter. No tyloses were noticed in any other part of these plants.

After permanent wilting and drying of the foliage four plants from each of the above two lots were watered regularly for about 3 weeks, in spite of which the stems started to die back. Examination of the stems at this stage showed extensive plugging of the vessels by tyloses not only in the die-back portions but also in the green portions immediately ahead of the die-back regions.

Two other plants, defoliated after permanent wilting, were watered regularly for about 3 weeks when they showed bud break below the die-back portion of the stems which contained tyloses. In one of these plants a few tyloses were found also in a small strip of heart wood at the collar.

A number of 7 month and 3 year old healthy plants kept as controls were completely free of tyloses.

All the above plants were free from attack by any pathogenic organism.

Tylose formation induced by wounds

Wounds, cuts, peeling of the bark etc., on any part of the tea plant stimulate the formation of tyloses.

Two tea bushes in plucking, approximately 40 years old, each having about 4 dozen branches were pruned into 3 year old wood in the first week of July (when the flow of sap is known to be very high). Longitudinal sections of six stems below the pruning cuts were examined after 1, 24, 48, 72, 96 and 168 hours of pruning.

Stems after 1 hour of pruning showed no tylose formation. Those collected after 24 hours showed initiations of tyloses, in the form of small arcs, in 4 out of 6 cases. All the stems obtained after 48 hours showed a moderate amount of tyloses, reaching one half to three fourths way across the vessels. The 72 and 96 hour stems showed profuse tyloses most of which were fully grown. By the end of one week (168 hours) all the vessels in a region of about 1.5 - 2 mm., starting from about 0.5 mm. below the cut surface, were completely occluded by tyloses. The tylose producing region was almost parallel to the cut surface.

Stems pruned in November when examined after 7 and 12 months showed similar tylose formation as above and almost in the same region. Sometimes the tylose forming region was found to extend down to about 5 mm. from the cut surface, such variations being dependent upon the roughness of the cuts.

Pruned roots of healthy bushes were found to develop moderate to profuse tyloses after about a week from pruning, almost in the same region as in the stems. It made no difference whether the cut end was left exposed to weather or immediately covered with soil. The severed portion of the root also formed tyloses where the parenchyma cells were still living. This agrees with the observations made by Gerry (1914) in felled logs.

Six month old healthy stems from which a V-shaped portion, extending to the centre, was cut away with a sharp knife showed after a week abundant tyloses on both edges of the cut.

Stubs of young, succulent stems left on the bush after plucking off the top two leaves and a bud were examined after about a week following plucking. Abundant tyloses were found about 0.5 mm. below the plucking wound.

The mid-rib of healthy, mature leaves, when severed with a razor blade about $\frac{1}{2}$ inch above the axil showed tylose formation at a distance of about 0.2 mm. on either side of the cut one week later.

Wounds caused on the stem by the removal of the bark induced tylose formation only in the vessels immediately below the exposed area.

There was no evidence of any fungal infection in the fresh wounds mentioned above; the old cuts on stems and roots sometimes contained some unidentified fungus mycelium.

Tylose formation in relation to fungal attack

Tylose formation has been noticed in branches killed by slow acting fungal parasites such as *Aglaospora aculeata*, Petch, *Nectria* sp., and *Poria hypobrunnea*, Petch, and also in rare cases of slow acting, primary root diseases such as *Helicobasidium compactum*, Boedjn., and *Hypoxylon asarcodes*, Theiss, Mill., but tyloses have not been observed in plants killed suddenly either by root disease producing fungi or by any other agency. Even in the former case tyloses are often sparse and they are to be found in the discoloured region of the stem. It appears to be the result of gradual shortage of water caused by the fungi concerned. Whether tylose formation has any relation to toxic action of the pathogens is a matter which requires further study.

Drought affected tea plants showing profuse tylose formation were often found to be free from any fungal attack.

Tylose formation in branches killed by parasites other than fungi

Profuse tylose formation has been noticed in tea branches killed by the slow action of a parasitic green plant of the *Loranthus* sp.

Contents of tyloses

The writer has not studied this aspect in detail but none of the substances such as starch, gum and calcium crystals mentioned by Gerry (1914) and Struckmeyer et al, (1954), came to his notice in the tyloses of tea during the course of his investigations. Younger tyloses, however, appear to contain protoplasmic substances. In rare cases pits were noticed in the tylose wall as observed by Struckmeyer and others (1954) in Oak.

Discolouration of the cambium and the sieve tissues

This condition has been consistently observed in tea plants visibly affected by water shortage. It is at first noticeable in the stem and at a later period in the roots as well. The discolouration varies in intensity according to the severity of damage to the plant. In lightly affected cases it appears as a light yellowish streak along the cambium, which gradually extends to the sieve tissues resulting finally in severe plasmolysis, (Pl. 1, Fig. 6). However, the discolouration in the cambial region does not show up if uprooted tea plants or cut branches are dried quickly in the sun. Cambial discolouration is usually but not invariably associated with the formation of tyloses (Pl. 1, Fig. 6).

Discussion

The absence of tyloses in healthy parts indicates that their formation is not a normal process in tea, but their appearance in tissues adjoining cuts and wounds and in plant organs suffering from gradual shortage of

water caused by drought or by the action of slow-acting pathogens suggests an association of tyloses with loss of water from the plant body.

According to Chattaway (1949) tyloses can only be formed in air-filled vessels bordering on living ray cells. Klein's (1923) earlier observations agree with this view. Gerry (1914) observed tylose formation 'to follow a reduction in internal pressure or cessation in sap conduction in the large vessels'. It appears therefore that the formation of tyloses is induced by the unbalance of pressure on the two sides of the pitted wall of a xylem vessel. Under conditions of water scarcity the hydrostatic pressure on the inner side of a vessel wall is reduced and the turgor of the parenchymatous ray cell abutting on the pitted wall of the vessel causes the pit membrane to stretch and arch into the vascular cavity. Further extension of these arcs into the characteristic bladder-like sacs is presumed by Gerry (1914) to be due to growth of the membranes by intussusception.

Appearance of tyloses in fungus-free wood does not support the view earlier held by Beckman and others (1953) that they are formed through toxic action of pathogens.

Beckman and others (1953) consider plugging of the vessels with tyloses to be the cause of wilting in Oak, whereas, in tea, tylose formation is usually preceded by wilting. The actual time of formation of tyloses corresponding to the manifestation of the external symptoms of water shortage appears, therefore, to be a characteristic of the two plants.

Summary

Tyloses are absent in the vessels of healthy parts of tea plants.

Tylose formation in tea is induced by wounds and gradual water shortage caused by drought or slow acting parasitic organisms.

Tyloses are not found in plants killed suddenly by rapid loss of water.

In tea plants subjected to water shortage tyloses are formed long after permanent wilting of the foliage.

Tyloses can be formed without the intervention of pathogenic organisms.

Cambial discolouration results from gradual shortage of water. This condition is usually associated with tylose formation.

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EXPLANATION OF PLATE 1

Fig. 1. Longitudinal section of a tea stem showing tyloses (T) growing from a parenchyma cell (P) into a vessel (V) - Note the open canals (C); nucleus (N). (X1000).

Fig. 2. Cross section of a tea stem showing tyloses (T) of various sizes. (X400).

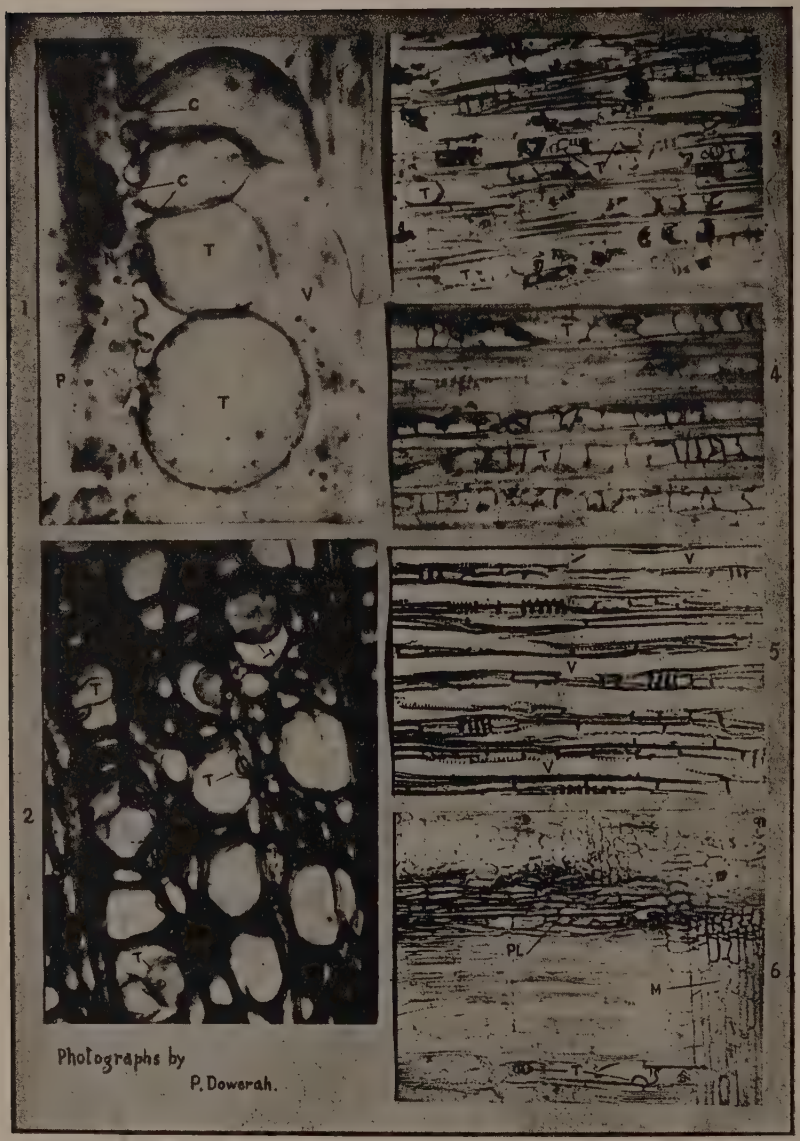
Fig. 3. Longitudinal section of a tea stem showing tyloses (T) of various sizes. (X100).

Fig. 4. Complete occlusion of vessels by tylose formation (T). (X100).

Fig. 5. Tylose-free vessels (V) in a 2 year old tea stem. (X100).

Fig. 6. Discolouration and plasmolysis of cambium and sieve tissues (Pl). M=medullary rays, T=tyloses. (X60).

PLATE 1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Photographs by
P. Dowerah.

STUDY OF THE EFFECT OF NUTRITION AND TEMPERATURE ON THE SIZE OF SPORES IN PIRICULARIA SETARIAE* NISHIKADO

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(Accepted for publication December 25, 1955)

It is a well known fact that the size of conidia in many plant parasitic fungi is influenced by nutrition and temperature. Thus Christensen (1922) and Dosdall (1923) have shown that the size of the spores of *Helminthosporium sativum* P.K. and B. varies on different culture media. Johann (1923) has shown that the size and the number of septa in spores vary in *Fusarium* species grown at different temperatures. Sueda (1928) has also shown that the dimensions of spores of *Piricularia oryzae* Cav. were found to vary according to moisture and temperature conditions. Since spore size is an important criterion in delimiting species of fungi within a genus, it was considered worthwhile to investigate as to what extent nutrition and temperature have effect on the spore sizes in *P. setariae* causing blast of *Setaria italica* Beauv. in Bombay State. The study was made by determining the size of spores obtained by growing the fungus in different nutritional media and temperatures under otherwise homogenious laboratory conditions. The effect of the factors on spore size was evaluated by Fisher's 't' test of significance.

Before starting the experiments, it was necessary to determine the minimum number of spores (for measurements of spore size) which would constitute a sufficiently representative sample and would render the comparisons statistically valid and accurate. For this purpose, the length of spores in random samples of 50, 100, 150 and 200 was measured, the fungus spores being taken from the natural lesions of blast on *Setaria italica* and potato dextrose agar culture. Measurements were made with the help of a Filar micrometer eyepiece having a least count of 0.207 microns and using natural reflected light. The mean standard deviation, standard error and standard error percent as of mean were calculated for each series of measurements. The results are given in table 1.

The results indicate that if spores were taken from naturally infected *S. italica*, the number to be measured to give a best sample was 200 since it has the least % error while in the case of the fungus grown on potato dextrose agar, it was also 200 for the same reason. It will however be observed from the table that the differences between the means of the independent samples of 50, 100, 150 and 200 spores obtained from the same source were not significant on the basis of the 't' test conducted by the formula

$$\frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\Sigma_1^2}{n_1} + \frac{\Sigma_2^2}{n_2}}} = t$$

* The species *P. setariae* Nishikado is referred to by some authors as *P. grisea*.

when $_1\overline{X}$, n_1, Σ_1, and $\overline{X}_2$, n_2, and Σ_2 were the respective means, sizes and standard deviations of the two independent samples. It was therefore appropriate to take observations of 100 spores or more in the case of the fungus from naturally infected host lesions and 50 or more in the other case.

Effect of Nutrition on Spore Size

The fungus was grown in petri dishes at room temperature (24-26.C) on the following media (1) potato dextrose, (2) oatmeal, (3) Brown's, (4) *Setaria italica* leaf decoction with and (5) without dextrose, (6) rice leaf decoction and (7) *Eleusine coracana* leaf decoction agars. When the fungus had grown and sporulated well, spores were mounted in sterile water and measurements recorded as described earlier. The conditions were perfectly uniform except the difference in media whose effect on the spore size was proposed to be studied. Fifty or more spores were measured for each medium, recording the length and breadth separately for each spore. For each nutritional medium, mean, standard deviation, and coefficient of variability were calculated. The means were compared between themselves and with the mean of the measurements of spores from natural host lesions by the application of Fisher's 't' (Fisher, 1946) test at five per cent level of significance. The results are recorded in tables 2 and 3.

This test of significance when applied to the data showed that the observed value of 't' is considerably more than the theoretical 't' at 5 per cent level of significance for spore length of the fungus growing on artificial media as compared to the length of spores from naturally infected host lesions. The only exception is the spore length of one month old fungus on potato dextrose agar which differs from the length of spores of first medium due to random sampling fluctuations only. This brings to light an important fact that nutrition plays a vital part in determining the length of spores of *P. setariae*. Among the effects of the different artificial media, spore length of fungus grown on rice leaf decoction agar is the greatest, spore lengths from potato dextrose, oatmeal and Brown's agar being significantly larger than those from one month old fungus on potato dextrose agar but smaller than those from *S. italica* decoction agar without dextrose.

In regard to spore width, the observed values of 't' are more than the theoretical values of 't' at 5 per cent level for spore obtained from oatmeal, Brown's, *S. italica* leaf decoction with dextrose, and *E. coracana* leaf decoction agars as compared to spores from naturally infected host lesions. The spores are narrower for these artificial media than those from host lesions. Similar effects of different media on spore measurements for length, width, septation and shape were also reported by Christensen (1922) and Dosdall (1923) for *H. sativum* and by Sueda (1928) for *P. oryzae*.

Effect of Temperature on Spore Size

Following these authors, it was considered feasible to investigate the effect of temperature on spore size of *P. setariae*. A similar count of 50 spores from 10 day old cultures grown on potato dextrose agar kept at 10,

TABLE 1

Statistical analysis of data for size of spore of *Piricularia setariae*.

Source of spores	Sample size (No. of spores measured)	Frequency distribution in no. of classes	Range (microns)	Mean (microns) ± S.E.	Standard deviation	Per cent standard error of mean
Naturally infected host tissue	50	16	16–32	22.6 ±0.45	3.14	1.982
	100	17	15–32	22.02 ±0.355	3.35	1.521
	150	17	15–32	21.71 ±0.24	2.95	1.105
	200	17	15–32	21.46 ±0.21	3.0	0.97
Potato dextrose agar	50	17	15–32	24.68 ±0.38	2.7	1.53
	100	17	15–32	24.45 ±0.304	3.04	1.24
	150	18	15–32	24.21 ±0.247	3.05	1.01
	200	18	15–32	24.29 ±0.213	3.05	0.87

TABLE 2

Variation for length of spores of *Piricularia setariae* from populations of different size from different nutritional sources

Conditions under which spores were produced (24° —26° C.)	Sample number	Number of spores measured	Range (microns)	Mode	Mean (microns) ±S.E.	Standard deviation	Coefficient of variability	t' value at 5% level when compared to sample I	Remarks about significance
Medium *S. italica* naturally infected	I	190	15–32	21.45	21.48 ±0.2	2.83	13.16	—	—
Potato dextrose agar (10 days' growth)	II	160	14–33	24.39	24.24 ±0.23	2.96	12.2	9.2	Significant
Oat meal agar	III	160	17–42	24.22	24.11 ±0.25	3.22	13.28	8.2	"
Setaria italica leaf decoction agar without dextrose	IV	100	21–34	25.81	26.06 ±0.23	2.34	8.9	8.03	"
do with dextrose	V	60	19–37	25.47	25.71 ±0.41	3.125	12.16	9.4	"
Brown's agar	VI	60	17–35	27.42	24.5 ±0.34	2.7	11.05	7.49	"
Secondary conidia	VII	50	16–33	22.4	24.18 ±0.43	3.09	6.18	5.7	"
Potato dextrose agar (1 month old)	VIII	50	14–33	20.38	21.38 ±0.54	3.86	18.13	0.17	Not significant
Rice leaf decoction	XI	50	22–33	28.33	27.26 ±0.39	2.78	10.1	41.8	Significant
Eleusine coracana leaf decoction agar	X	50	14–33	24.22	25.4 ±0.47	3.4	13.3	24.5	"

TABLE 3

Variation for width of spores of *Piricularia setariae* from populations of different size from different nutritional sources.

Conditions under which spores were produced	Sample number	Number of spores measured	Range (microns)	Mode	Mean (microns) ± S.E.	Standard deviation	Coefficient of variability	t' value at 5% level when compared to sample I	Remarks about significance
(24° — 26° C) Medium									
S. italica naturally infected	I	190	6.5–11.5	8.81	9.01 ±0.05	0.78	8.7	—	—
Potato dextrose agar (10 days' growth)	II	160	6.5–12.5	8.78	8.94 ±0.07	0.925	10.4	0.8	Not significant
Oat meal agar	III	160	6.0–13.0	8.82	9.31 ±0.07	0.85	9.1	3.4	Significant
Rala leaf decoction agar (without dextrose)	IV	100	6.5–11.0	8.87	9.12 ±0.06	0.6	6.3	1.4	Not significant
do (with dextrose)	V	60	6.5–11.5	8.76	8.78 ±0.09	0.75	8.56	2.2	Significant
Brown's agar	VI	60	6.0–12.5	7.75	7.55 ±0.12	0.92	12.18	11.2	"
Secondary conidia	VII	50	7.0–11.0	8.31	8.53 ±0.11	0.8	9.3	3.9	"
Potato dextrose agar (one month old)	VIII	50	7.0–12.5	8.83	9.24 ±0.16	1.15	12.44	1.3	Not significant
Rice leaf decoction agar	XI	50	8.0–10.5	9.0	9.2 ±0.04	0.29	3.1	1.93	"
Nachani leaf decoction agar	X	50	6.0–9.5	7.86	8.23 ±0.9	0.65	7.9	6.6	Significant

TABLE 4

Effect of temperature on length and width of spores of *Piribularia setariae*

Temperatures compared °C	Mean length of spores			Mean width of spores		
	Mean (microns)	Difference	Standard error or difference	Mean (microns)	Difference	Standard error or difference
10–15	23.08 24.44	—1.36	0.74	9.18 9.04	+0.14	0.16
10-20	23.08 24.00	—0.92	0.72	9.18 9.14	+0.04	0.16
10–25	23.08 24.6	—1.52*	0.55	9.18 8.86	+0.32	0.16
10-30	23.08 22.78	+0.30	0.66	9.18 9.06	+0.12	0.17
15-20	24.44 24.0	+0.44	0.69	9.04 0.14	—0.10	0.15
15–25	24.44 24.60	—0.16	0.50	9.04 8.86	+0.18	0.15
15-30	24.44 22.78	+1.66*	0.62	9.04 9.06	—0.02	0.17
20–25	24.00 24.60	—0.60	0.47	9.14 8.86	+0.28	0.15
20–30	24.00 22.78	+1.22*	0.60	9.14 9.06	+0.08	0.17
25-30	24.6 22.78	+1.82*	0.37	8.86 9.06	—0.20	0.17

* Significant

15,20, 25°C. and 30°C. was made. The results statistically analysed are reported in table 4.

It is observed that the lowest and the highest temperatures i.e. 10°C. and 30°C. gave shorter average length as compared to other temperatures. The differences in length for temperatures (10,25), (15,30), (20,30) and (25,30) are alone statistically significant showing that 30°C. temperature shortens the length of the spore in comparison with that at 15°, 20°, and 25°. The length at 25 °C. is significantly more than that at 10° C. Temperature, however, has no significant effect on width of the spore.

Summary

The effect of artificial nutritional media and temperatures on the spore size of *P. setariae* studied by using statistical constants for each sample showed that measurements of at least 100 spores were necessary for obtaining representative measurements in the case of spores from natural host lesions and 50 for spores from artificial media.

The results showed four types of variations as regards effect of artificial media on spore size: (1) Significant increase in length and width of spores from oatmeal, *Setaria italica* leaf decoction with dextrose and *Eleusine coracana* leaf decoction agars, (2) Significant increase in length but not in width of spores from potato dextrose, *S. italica* leaf decoction without dextrose and rice leaf decoction agars, (3) Significant increase in length accompanied by a significant decrease in width of spores from Brown's agar and secondary conidia and (4) Length and width of spores not significantly changed from one month old potato dextrose agar when compared with those from natural lesions.

Temperature has practically no effect on width of the spore but length was shortened at 10°. and 30°C. and increased at 15, 20 and 25°.

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A SIMPLE METHOD FOR PRODUCING APOTHECIA OF SCLEROTINIA SCLEROTIORUM (LIB.) DE BARY

KISHAN SINGH BEDI

(Accepted for publication December 28, 1955)

For obtaining apothecia of different *Sclerotinia* spp., moist sand or soil has been used by Jagger (1920), Beach (1921), Godfrey (1923), Ezekiel (1924), Young and Morris (1927), Harrison (1935), Young (1936), Drayton (1937) and Coe (1944). In addition to moist sand, Joshi (1924), and Mundkar (1934) used sterilised moistened saw-dust for this purpose. Kheshwala (1934), who used moist sand, saw-dust, and clayey soil, obtained the largest number of apothecia of *Sclerotinia sclerotiorum* in saw-dust and the least number thereof in the clayey soil. This difference seems to be due to the presence of adequate air supply in the former case and due to insufficient aeration in the latter case.

Wadham (1925) used wet cotton wool in sterile culture tubes to produce apothecia from sclerotia of *S. trifoliorum*. Joshi (1924) obtained stipes from the sclerotia of *S. sclerotiorum* in cultures growing on corn, oat, wheat and bean meal agar media. Similarly, Godfrey (1923), Ramsey (1925), Kheshwala (1934) and Mundkur (1934) obtained only stipes from the sclerotia of *S. sclerotiorum* on different agar media. Thus, the germination of sclerotia, as obtained by these workers, was not effective in as much as the stipes produced did not expand into apothecia with functional ascospores.

Hensen and Valleau (1940) developed a technique for the production of stipes and apothecia of *S. sclerotiorum* and *S. trifoliorum* by placing the sclerotia of the two species on one per cent water agar slanted in 8.5 by 2 cm. vials tightly plugged with cotton.

The following advantages of the water agar method are claimed by the authors:

"(1) Uniform moisture is maintained for a relatively long time without attention.

(2) Sclerotia may be watched without disturbing them for the first appearance of the stipes.

(3) The behaviour of a large number ot sclerotia may be studied in a comparatively limited space and with very little attention.

(4) The effect of time, temperature and light may be studied independently.

(5) Contaminating organisms do not grow well, and the mycelial growth of sclerotia, if any, is usually sparse".

The writer in his studies on the factors controlling the formation of apothecia by the Punjab strain of *S. sclerotiorum* isolated from the plants of gram (*Cicer arietinum* L.), affected with the stem-rot disease at Gurdaspur, tried moist sand, moist cotton wool, moist filter papers and one per cent water agar, all after sterilization in the autoclave, and obtained varying degrees of success in the production of apothecia from the sclerotia. A simpler, more rapid and more effective method was, however, the desideratum. In one experiment, some of the cultures of *S. sclerotiorum* had to be exposed to 100 per cent humidity. For this purpose, some Erlenmeyer flasks containing potato-dextrose agar, on which a good crop of sclerotia had developed, were inverted after removal of plugs over one-quart Mason jars containing water at the bottom. A few sclerotia from the surface of one inverted culture got detached and landed on the surface of the water in the Mason jar below. They did not sink, but kept floating. At the end of a certain period, each floating sclerotium put forth a number of brown, slender stipes, which eventually expanded into large-sized, normal apothecia with well-developed asci containing hyaline, unicellular ascospores.

The writer was in search of a superior method, and it came his way through sheer accident. The method was tried on a larger scale by deliberately floating sclerotia on water in different receptacles. It gave excellent results. The writer has used this method in his studies in preference over other methods. The method, along with the precautions to get the best results, is described below:

Float sclerotia on distilled or tap water, which it is preferable to sterilise. For holding water, use any glass vessel, which must not be coloured. The writer has successfully used Erlenmeyer flasks of all sizes, medicine bottles, Mason jars and deep Petri dishes. To prevent dust and other contaminants from falling in, the mouths of the vessels should be covered e.g., Erlenmeyer flasks and medicine bottles with only loose cotton plugs, Mason jars with their caps and Petri dishes with their lids. To provide adequate aeration for use by the floating sclerotia during germination, the vessels should be filled only about one-third with water. Most of the sclerotia freshly harvested from cultures keep floating on water, if they are gently placed on it, and if it is desired that all of them must float, they should be air-dried at room temperature for a day or two. Dry sclerotia do not sink, and once a sclerotium floats, it will keep floating unless and until the vessel containing it is violently shaken. It is not necessary to treat the sclerotia with any surface disinfectant before transferring them to the surface of the water in the glass receptacle.

The vessels containing the floating sclerotia should be placed at a temperature range of 15° to 20°C. to obtain good results. Light is essential for the stipes to expand into apothecia. Hence the vessels containing the floating sclerotia should be placed in a room with good light.

In the writer's opinion, no simpler, more rapid and more effective method for producing apothecia from sclerotia can be conceived. It has all the advantages which Hansen and Valleau (1940) claim for their method of planting sclerotia on one per cent water agar in tightly-plugged vials.

On the other hand, the writer's method has the following additional advantages.

(1) Contaminating organisms do not grow in water and, thus, do not interfere with the development of apothecia from the floating sclerotia. Hansen and Valleau (1940) themselves mention that some of the sclerotia of *Claviceps purpurea*, which they had planted in vials containing one per cent water agar, were overgrown with other fungi and failed to produce stipes.

(2) The germination of sclerotia floating on water starts only with stipes and not with mycelium. On the other hand, Hansen and Valleau (1940) themselves admit that some mycelial growth occurs from sclerotia planted on water agar. The writer observed in his experiments that a colony of mycelial growth occurs from sclerotia planted on water agar in slants, Perti plates and Erlenmeyer flasks. Howsoever small the amount of mycelium thus arising may be, it is a definite drain on the sclerotial reserves, which would otherwise be utilised in the formation of the fruiting bodies. In the writer's experiments, the most vigorous development of apothecia took place only on substrates free from any nutrition, because the presence of nutrients in them invariably induced the formation of some mycelium from the sclerotia and this was invariably reflected in the debilitated, and sometimes abortive, condition of apothecia. Hansen and Valleau also mention that on water agar only 75 to 85 per cent sclerotia produce apothecia and the average number of apothecia produced by each sclerotium is 1.5. This, in the writer's opinion, is a low figure and is evidently due to the vigour of the sclerotia having been reduced by the mycelial growth that develops from them on the agar medium.

In the case of sclerotia floated by the writer on distilled water, 100 per cent of them produced apothecia, and the average number of apothecia per sclerotium was 4.0, and their average diameter was 3.5 millimetres, showing thereby that they were normal and well-developed.

(3) In Hensen and Valleau's method, due to the use of tight plugs, which are necessary to retard the drying-out of the agar medium, the sclerotia are subjected to inadequate aeration, which, in the experience of the writer, cannot but adversely affect the apothecial development. In the writer's method, the cotton plugs are very loose and the air space (2/3 capacity of the vessel) is more than adequate. Even an occasional removal of plugs of Erlenmeyer flasks and medicine bottles, caps of jars or covers of Pertri plates and replacing them after a little while in order to ensure exchange of air in the vessel may be resorted to with little or no fear of contamination.

(4) Many sclerotia, 50 to 100, may be floated in an average-sized Erlenmeyer flask or a Mason jar instead of a number of vials of 8.5 by 2 cm. size containing water agar, as used by Hensen and Valleau.

(5) The writer's method does not need any expensive material like agar. Though it is recommended that for finer type of work, the water

to be used for floating sclerotia may be distilled and also may be sterilized, yet equally good results can be obtained whether distilled sterilized water or fresh water from the tap is used.

The apothecia of *S. sclerotiorum* (Lib.) de Bary produced by the writer by floating its sclerotia on water may be seen in the figure.

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EXPLANATION OF PLATE

Fig. 1. Production of apothecia from the sclerotia of *Sclerotinia sclerotiorum* (Lib.) de Bary by floating them on water for about 6 weeks.

PRESERVING VIABILITY OF RICE SEEDS WITH FUNGICIDES

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Introduction

The main sowing season for rice in most parts of India commences with the advent of the monsoon season in June. In certain localities, however, there is a second sowing in August–September (Malabar and South Canara Districts of Madras) or even later in the months of December-January (*Boro* or *Daluva* in Eastern or North-Eastern India). In Malabar, seeds for the later sowings are obtained from neighbouring districts, which are comparatively dry. In the Godavari delta, seeds are raised in specially sown seed–plots in the main season from which they are harvested and immediately sown. Such methods are adopted because seeds stored through the intervening humid monsoon season lose their viability. Whether such a loss in viability sustained by rice seeds during storage in mosnoon season could be prevented by treatment of seeds with fungicides was investigated at the Central Rice Research Institute. Chilton and Ryker (1947)* have reported that rice seeds treated with "Arasan" and stored, gave better germination than untreated seeds in monthly tests made during seven months of storage. The studies reported below were carried out in the two crop seasons of 1948-49** and 1949-50.

Materials and Methods

In the first year, *viz.*, 1948–49, the following fungicides, "Agrosan G.N.", "Arasan", "Phygon" and Spergon" were used at three levels, viz., 1/250, 1/500 and 1/750 by weight of seeds. In the second year three more fungicides, viz., "T.M.T.D., "Cuprocide" and "Aagrano", were tried against the more efficient treatments of the first test, *i.e.*, "Phygon" and "Spergon" at 1/500 level. "Arasan" used in the first year and "T.M.T.D." ased in the second are proprietary formulations of the same chemical.†

Seeds of ten varieties of rice, *viz.*, ADT., 4., N. 136, B. 76, *Benibhog*, T. 1145, T. 90, T.812, GEB. 24, T. 412 and FR. 43–B were included in the first year. Except ADT. 4, all the varieties used in the first were used in the second test and three new varieties, *viz.*, T. 608, T. 380, and T. 1242 were also included.

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* Chilton, S. J. P. & Ryker, T. C. (1947). Seed treatment of rice: Louisiana State University Bull. N. 412.

** A paper was read at the Indian Sci. Congr. Session at Allahabad in 1949, in which the chief finding of the experiment conducted in 1948 were presented. (See Abst. Ind. Sci. Congr. 1949). Agri. Sciences:

† McCallan et al (1955) Chemicals names for active ingredients of fungicides. *Phytopathology* **45**: 295-302

The seeds were sun-dried thoroughly and treated with the fungicides. After treatment the seeds were stored in small cloth bags. One lot of seeds of each variety was left untreated to serve as control. The bags were stored in metal bins according to treatments. In the second test, a set of seeds was also kept in screw-capped bottles.

The tests were carried out from January to September, 1948 and from April to October, 1949. In the first year, on the 6th of each month, beginning from February (a month after storage) two samples of 100 seeds each were drawn from the bags and put for germination tests. In the second test conducted during 1949, the viability was determined only during June, August, and October after the initial determination in April giving 95-100% germination for all varieties stored.

Results

The varieties might be conveniently considered in three groups on the basis of their viability in storage and their response to fungicidal treatment. In the varieties of the first group (T. 608, T. 90, T. 812, and N. 136) deterioration in viability sets in early and is totally lost by September-October, whether stored in bottles or in bags. The fungicidal treatments were only effective in slowing down the rate of deterioration. After the onset of the monsoon rains, deterioration in germinability set in the July test in 1948 during the first week of the month and in the June test in 1949 in the last week of the month.

In the second group of varieties consisting of ADT, 4, B. 76, *Benibhog*, and T. 1145 there was almost a total loss of viability in the case of seeds stored in bags at the end of the storage periods, but only a slight loss was sustained when stored in bottles. Deterioration set in later than in the varieties of the first group. Under many of the fungicidal treatments, especially under Cuprocide at 1/500 level, the viability of seeds was maintained unimpaired till the end of the test. (Table I & III)

In the varieties of the third group consisting of T. 380, F.R. 43-B, T. 1242, GEB. 24 and T. 412 there was no loss in viability when stored in bottles and even in bags the deterioration set in only towards the end of the monsoon period. Even in October test the germination ranged from 25 to 68 per cent in the seeds stored in bags. Under most of the fungicidal treatments, germination remained unimpaired till the end of the test. Cuprocide at 1/500 level was the most outstanding in this respect with all the varieties of this group, while "Aagrano", "Phygon", "Spergon", "Arasan" or "TMTD" and "Agrosan" were as effective as Cuprocide only in the case of T. 380 and FR. 43-B. (Table I & III)

It is interesting to record that in the case of four of the late maturing types (FR. 43-B, T. 90, GEB. 24, and T. 412) out of the five included in the test, fungicidal treatments were seen to be associated with a distinct increase in germination over that in the untreated series in the first test made in February 1948. (Table I)

Discussion

Deterioration in the viability of rice seeds occurred in all varieties of rice when they were stored through the months of July-October (Monsoon months) at Cuttack. This deterioration could be slowed down when the seeds were stored after treatment with some fungicides. The extent to which the viability of seeds could be preserved in storage appeared to depend upon: (i) the condition of storage, (ii) the variety, (iii) the fungicide, and (iv) the level of fungicidal treatment.

As might be expected, there was a general deterioration in the viability of the seeds of all varieties when stored in cloth bags but even when stored in bottles, four (T. 608, N. 136, T. 90 and T. 812) out of the thirteen varieties included in the test lost their viability. The rate of deterioration differed widely among the varieties and was the most rapid in the four varieties mentioned above. Except in these four varieties, the viability could be maintained unimpaired till the end of October even in the case of seeds stored in bags under some of the fungicidal treatments.

Of the varieties in the first group discussed above, the grains of T. 608, T. 90 and N. 136 are practically indistinguishable from one another, while T. 812 possesses grains which are similar in shape to those of other three, though darker in colour. They are superfine rices, thin, and elongated with fine tapering pointed ends. There was no relation between the viability in storage and the other types of grains included in the study, neither was there any relation between the duration of growth period of the varieties and their germinability.

Of the fungicides tried "Cuprocide" was the most effective in arresting the fall in the germinability of the seeds, though "Spergon", "Phygon" and "TMTD" or "Arasan" were also somewhat effective. The level of the fungicidal treatment appeared to be important, the most effective level being 1/500 by weight of seeds. It was of interest to note that some of the fungicides stimulated the germination of the seeds of the late varieties when tested in February, a couple of months after harvest. Further investigations are necessary to understand the precise role of fungicides in slowing down the fall in viability of treated seeds in storage.

In conclusion it may be stated that, where storage of seeds through rainy season is inevitable, the seeds should be stored after treatment with some of the more effective fungicides. At the level of 1/500 by wieght of seeds, the cost of treating a lot of ten lb. of seed will not be more than one anna. Since the fungicidal treatment was effective in preserving the viability of seeds even when they were stored in bags, it might be expected that they would also be equally effective in the case of seeds stored in straw twist bundles or in gunnies.

Summary

The effect of fungicidal treatment of rice seeds on the preservation of their viability during storage, especially during the monsoon season, was studied in two experiments, one in 1948 and the other in 1949.

"Agrosan GN", "Arasan", "Phygon" and "Spergon" were tried in the first year. The fungicides were used at three levels, *viz.*, 1/250., 1/500 and 1/750 by weight of seeds. Seed of ten varieties of rice were used in the first experiment and twelve in the second. The viability of the seeds was tested monthly from February to September in 1948 and in April, June, August and October, in 1949.

Of the fungicides tried Cuprocide at 1/500 level was found to be most effective in preserving the viability of seeds.

Certain superfine varieties of rice with thin long grains and with finely pointed ends lost their viability most rapidly during storage through the monsoon period (July–October) and even the best fungicidal teatment was only partially helpful in slowing down the rate of deterioration in viability . The viability of other types of grains was preserved more or less unimpaired under the more efficient fungicidal treatments till the end of September or October.

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(For Tables I—III see next 4 pages)

Table I.

The percentage germination of rice seeds treated with different
Results of the first test in February, and the sixth, seventh

Variety.	Month of Test	FUNGICIDAL TREATMENTS					
		AGROSAN GN.			ARASAN.		
		1/250	1/500	1/750	1/250	1/500	1/750
Benibhog	February	97.0	96.0	96.0	92.0	94.6	90.0
	July	99.5	98.0	94.5	96.5	97.0	98.5
	August	94.0	85.5	22.0	76.5	76.0	87.5
	September	15.0	80.5	2.5	1.0	2.0	32.0
Adt. 4.	February	94.0	91.0	87.0	87.5	96.0	90.0
	July	94.0	95.0	92.5	92.5	96.0	94.0
	August	84.5	74.5	70.0	70.5	72.5	82.0
	September	7.5	11.0	3.5	2.0	1.0	32.0
N. 136	February	97.5	98.0	95.5	94.0	91.5	92.5
	July	93.0	91.5	93.0	93.5	98.0	90.5
	August	95.0	85.0	73.5	73.5	74.5	88.5
	September	11.0	8.0	1.5	0.0	0.0	19.5
B. 76.	February	96.5	97.5	98.0	98.0	94.0	95.5
	July	99.5	97.0	93.0	93.0	99.0	97.5
	August	99.5	71.5	43.0	43.0	35.0	79.5
	September	2.0	0.5	0.0	0.0	0.0	14.0
T. 1145	February	94.5	93.0	88.0	93.0	92.5	91.5
	July	93.0	91.5	93.0	93.5	98.0	90.5
	August	95.0	85.0	73.5	73.5	74.5	88.5
	September	11.0	8.0	1.5	0.0	0.0	19.5
T. 412	February	69.5	63.5	66.0	49.5	49.5	57.5
	July	99.5	97.5	97.5	98.5	98.5	96.5
	August	95.5	95.5	93.5	90.5	90.5	90.5
	September	40.5	50.1	35.5	17.0	22.0	70.5
G.E.B.24	February	50.5	36.5	42.5	29.0	33.0	35.5
	July	96.5	98.5	94.0	98.5	99.0	98.5
	August	91.5	93.0	77.5	79.5	84.0	93.0
	September	36.5	16.0	7.5	0.0	1.0	43.5
T. 90	February	86.0	85.0	91.5	75.0	86.5	81.5
	July	80.0	88.5	68.5	88.5	93.0	87.5
	August	18.0	15.0	15.5	12.0	16.5	30.0
	September	0.5	0.5	0.5	0.0	0.0	1.0
T. 812	February	96.0	97.5	96.5	97.5	96.0	98.5
	July	94.5	97.5	74.0	85.5	92.5	98.0
	August	48.5	7.0	4.0	4.0	1.5	25.5
	September	0.0	0.0	0.0	0.0	0.0	0.0
FR 43.B	February	69.0	62.5	72.5	69.0	64.0	86.0
	July	99.5	99.5	98.5	98.0	99.5	99.5
	August	96.0	84.0	72.5	73.5	64.5	93.5
	September	9.5	9.0	4.0	0.5	1.0	25.0

*The germination percentage was uniformly high

Table I.

fungicides during storage from January - September, 1948. and eigth tests in July, August and September respectively.*

at 3 levels by weight of rice seeds.

PHYGON.			SPERGON			Control	REMARKS
1/250	1/500	1/750	1/250	1/500	1/750		
95.0	96.5	94.5	96.0	95.0	95.0	97.0	110 days duration·
97.5	99.0	98.0	82.5	98.0	99.0	99.0	
90.5	92.5	94.5	90.0	90.0	86.0	68.0	
46.5	69.5	28.0	36.0	64.5	15.0	7.0	
91.5	94.5	96.5	91.0	91.5	92.5	94.0	110 days duration·
95.5	94.5	93.5	94.5	93.0	91.0	95.0	
86.0	87.0	88.0	83.5	80.0	83.5	66.5	
53.5	54.0	15.5	61.5	67.5	39.5	4.0	
90.5	96.0	95.5	98.0	97.0	95.0	97.0	120 days duration·
94.0	91.5	87.5	90.5	95.5	91.5	81.0	
85.0	91.5	78.0	85.5	91.5	86.5	14.5	
50.5	65.0	3.0	31.5	76.0	25.5	0.0	
97.0	96.5	96.0	98.0	98.0	97.5	98.5	120 days duration·
96.5	96.5	96.5	97.5	97.0	96.5	99.0	
75.5	90.5	90.5	85.0	92.5	79.5	48.0	
0.0	33.5	2.0	31.0	25.0	11.0	0.0	
90.0	92.5	86.0	84.5	94.0	93.5	83.0	140 days duration.
94.0	91.5	87.5	90.5	95.5	91.5	81.0	
85.0	91.5	78.0	85.5	91.5	86.5	14.5	
50.5	65.0	3.0	31.5	76.0	25.5	0.0	
60.0	53.5	46.0	54.5	51.0	54.0	40.0	150 days duration.
98.0	98.0	98.0	97.0	98.5	96.5	96.5	
91.0	99.5	99.0	95.5	94.0	94.0	84.5	
77.5	89.0	56.5	82.0	88.0	64.5	15.5	
26.0	34.0	26.0	24.0	43.5	38.0	27.5	155 days duration·
96.5	99.0	98.0	96.0	99.5	98.0	99.5	
89.5	98.5	94.5	94.5	95.5	92.0	85.5	
65.5	89.5	29.0	76.5	86.5	43.0	9.5	
71.0	77.0	67.0	63.0	74.5	79.0	55.0	155 days duration.
76.0	82.0	80.5	78.0	—	—	85.0	
46.5	62.0	24.5	75.0	66.0	11.6	5.0	
6.0	7.0	0.5	86.0	46.0	2.5	0.5	
93.0	96.0	96.0	99.0	98.0	96.5	97.0	160 days duration.
96.5	98.5	87.5	96.5	96.0	87.0	98.5	
28.5	85.0	78.0	73.5	80.5	34.0	1.5	
0.0	2.5	3.0	0.5	2.5	0.5	0.0	
63.0	63.0	61.5	51.5	66.5	76.0	54.5	160 days duration·
99.0	99.0	99.0	98.5	98.5	98.0	99.5	
92.0	95.5	94.5	93.5	93.0	93.5	47.0	
58.5	73.0	44.0	53.0	74.5	30.0	1.0	

(95—100%) during March, April, May and June.

Table II

Showing the rapid deterioration in germinability in storage through monsoon of 4 varieties of rice, and their response to fungicidal treatments in arresting loss in germinability in storage (1949 test)

Variety.	Month of test	Stored in	FUNGICIDAL TREATMENTS											
			Phygon 1/500	Spergon 1/500	T.M.T.D. 1/250	T.M.T.D. 1/500	T.M.T.D. 1/750	Guprocide. 1/250	Guprocide. 1/500	Guprocide. 1/750	Aagrano. 1/500	Aagrano. 1/500	Aagrano. 1/750	CONTROL
No. 136	June	Bags	89	82	81	81	80	85	88	93	74	91	77	43
	June	Bottles	No deterioration in germinability even in untreated state.											
	August	Bags	77	75	73	70	63	61	82	78	77	75	59	2
	August	Bottles	77	73	70	77	74	61	79	76	64	74	68	7
	October	Bags	17	21	5	22	5	6	48	53	1	4	5	0
	October	Bottles	45	49	56	60	47	48	77	60	8	53	35	0
T. 9	June	Bags	96	93	93	90	92	95	94	93	94	92	95	39
	June	Bottles	No deterioration in germinability even in untreated state.											
	August	Bags	90	94	95	94	84	42	92	97	87	92	89	2
	August	Bottles	93	87	92	92	90	94	89	92	88	89	89	1
	October	Bags	18	28	11	16	6	6	36	51	5	11	23	0
	October	Bottles	57	63	73	85	67	63	82	79	51	76	51	0
T. 608	June	Bags	91	84	81	77	82	77	86	89	79	74	88	66
	June	Bottles	No deterioration in germinability even in untreated state.											
	August	Bags	75	80	79	83	68	59	78	80	66	61	53	23
	August	Bottles	73	69	68	73	68	79	70	73	69	73	70	0
	October	Bags	x	32	9	31	8	4	39	37	0	5	6	3
	October	Bottles	62	52	52	58	48	42	59	58	32	52	67	0
T. 812.	June	Bags/Bottles	No loss in viability noticed even in untreated condition.											
	August	Bags	88	91	100	92	92	x	94	95	95	95	87	91
	August	Bottles	93	94	95	91	92	75	86	92	66	96	93	37
	October	Bags	4	9	2	10	4	2	29	42	0	11	8	1
	October	Bottles	54	55	50	56	36	24	69	64	18	85	73	4

Table III.

Table showing the germination percentage of 8 varieties of rice under treatment with fungicides during storage in monsoon showing a very high response to fungicidal treatment in preservation ofviability in storage. Seeds stored in bags (1949 test).

Variety	Month of test.	FUNGICIDAL TREATMENTS.											
		Phygon 1/500	Spergon 1/250	T. M. T. D. 1/500	T. M. T. D. 1/750	T. M. T. D. 1/250	Cuprocide. 1/500	Cuprocide. 1/750	Cuprocide. 1/250	Aagrano 1/500	Aagrano 1/500	Aagrano 1/750	Control.
T. 1145	August	100	97	98	99	97	95	96	99	98	100	98	1
	October	63	63	34	57	57	39	93	91	21	77	88	0
Benibhog	August	93	93	90	94	91	93	94	89	90	95	91	23
	October	82	91	65	88	76	65	92	89	54	79	81	1
B. 76	August	No loss in germination even in untreated state.											
	October	80	60	50	82	37	25	83	93	7	61	62	11
T. 412	August	No loss in germination even in untreated state.											
	October	x	80	68	80	71	x	91	83	76	79	85	25
T. 380	August	No loss in germination even in untreated state.											
	October	92	94	84	92	81	89	93	90	81	86	87	35
T. 1242	August	No loss in germination even in untreated state.											
	October	43	71	54	67	58	47	93	95	x	57	76	50
FR. 43. B	August	No loss in germination even in untreated state.											
	October	93	97	88	82	89	79	98	97	75	78	90	62
G. E. B. 24.	August.	No loss in germination even in untreated state.											
	October	58	87	68	92	63	59	96	96	50	73	91	86

TWO NEW RECORDS OF PIRICULARIA SPECIES FROM INDIA

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(Accepted for publication January 5, 1956)

The genus *Piricularia* established by Saccardo includes several species of which *P. oryzae* Cav. is of great economic importance inciting the blast disease of rice. *Piricularia* species on other plants either acting as collateral hosts for *P. oryzae* or distinctly separate species have been reported from time to time. Uptil now, *Piricularia* species have been reported on members of the Gramineae, Cyperaceae and Zingiberaceae. As pointed out by Luttrell (1954)*, *P. aquatica* and *P. submersa* described by Ingold may not belong to the genus *Piricularia*. In the present paper, a brief account of the morphology, cultural studies and cross inoculation experiments with two *Piricularia* species, one on *Cyperus compressus* L. and another on *Commelina benghalensis* L. collected near Poona, Bombay , is presented.

Cyperus compressus is a common weed in the low lying parts in the fields. Severe leaf blotching accompanied by a wet rot incited by a *Piricularia* species was noticed during the months of August and September. Infection spots first appeared as yellowish–brown flecks and gradually enlarged into elliptic spots with greyish–white centre and bordered by deep-brown margin (Fig. 6). During wet weather conditions, the infection spots near the collar region girdled the leaf base and brought about the wilting of the leaves. The fruiting was profuse on these spots during humid weather appearing as greyish-white fuzz.

Microscopic examination of the infection spots revealed the intercellular mycelium and the formation of conidiophores emerging through the stoma. The conidiophores are pale yellowish–brown, septate, geniculate at the tip and bear numerous conidia. Mature conidia are hyaline to pale olivaceous, obclavate, narrow towards the apex, mostly, 2-septate and measuring 19-32x 8-13μ (mean 26.5x11.2μ) (Fig.7).

As regards the identity of the fungus, it closely resembles *Piricularia higginsii* Luttrell recently described by Luttrell (1954) on *Cyperus rotundus* L. from Georgia, U.S.A. In the type of symptoms produced and shape of the conidia, there is a close resemblance. Mature conidia in *P. higginsii* measure 17.5-33.4x 5.8–6.4μ while in the fungus under study they are 19–32 x 8–13μ. The spores in the fungus studied by us are, therefore, broader than those of *P. higginsii* in which the maximum width of conidia is less than 7μ. To indicate this characteristic difference, the *Piricularia* species under study is presented as a new variety with the name *P. higginsii* Luttrell var. *poonensis* var. nov.

*Luttrell E. S.(1954) *Mycologia* **46**: 810-814.

The fungus was isolated in pure culture from germinating conidia. On potato dextrose agar and Moyer's agar, the fungus produced dense white mycelium at first which gradually turned greyish–white to black. Sporulation on agar was sparse and the spores formed were of the same shape but slightly smaller in size than those produced naturally on the host. In old cultures, the submerged hyphae turned black and produced numerous black sclerotia which were up to 100μ in diameter and closely resembled those produced by *Macrophomina phaseoli* (Fig. 8). These sclerotia were composed of thick–walled, deep, brownish–black cells which resembled chlamydospores (Fig. 9.). Occasionally, large number of hyphae grouped together into fasciculate or ropy structures were formed (Fig. 10).

On leaves of *Commelina benghalensis* L. a *Piricularia* species was collected also in the months of August and September near Poona. The infection was quite extensive and the symptoms produced on the host were unlike those of any other *Piricularia* species on graminaceous hosts. Instead of elongated lenticular blotches, the infection spots were circular, greenish–black, 4–6. m.m. in diameter with zonations. The margin of the infection spot was elevated and slightly thickened (Fig. 1). During wet weather, the fruiting structures of the fungus appeared as greyish–white fuzz bearing numerous spores on the lower leaf surface.

Microscopic examination of the infection spot revealed the intercellular hyphae traversing the mesophyll tissue. The conidiophores broke from within the epidermal cells arising from small knots of hyphae (Fig. 2). The conidiophores are very pale olivaceous at base, hyaline at top, bearing conidia at the tip. The conidiophores are 1–2 septate and bulbous at the place of attachment on the host. Mature conidia are hyaline to very pale olivaceous, pyriform, chiefly 2–septate, with a small hilum at the base, indicating the point of attachment. Mature conidia measure 21–30 x 10–13μ with a mean of 25.4 x 11μ.

The fungus was isolated in artificial culture from germinating conidia. The growth on potato dextrose agar and Moyer's agar is quite profuse, developing white flocculent mycelium. In due course, the mycelium turns greyish-white to sooty–black in colour. In general appearance, the cultures of *P. higginsii* var. *P poonensis*, *P.oryzae* and *P. grisea* on *Setaria italica* look alike, with white floccose hyphae in the beginning, gradually turning fumaceous to gray in due course. The hyphae in *Piricularia* species on *Commelina benghalensis* are septate, with large number of swollen cells interspersed (Fig. 4). No sclerotia are produced as in *P. higginsii* var. *poonensis*, but thick–walled dematiaceous hyphae, forming hyphal knots are found in the old cultures (Fig. 5).

As regards the identity of the fungus, it resembles *P. oryzae* and *P. grisea* in general shape of the conidia. In *P. oryzae*, the conidia measure 20–25 (up to 37μ) x 10–14μ., while in the species under study they are 21–30 x 10–13μ. The types of symptoms produced on the hosts are different on the two hosts, and all attempts to cross inoculate *P. oryzae* on *Commelina benghalensis* have failed. While it may be feasible to consider the fungus on *C. benghalensis* as a distinctly separate species from *P. oryzae*, to indicate

the close morphological resemblance with it, it is proposed to name it *P. oryzae* Cav. var *commelinae* var. nov.

Inoculation experiments were carried out on each host using the respective isolates from them. Fragments of hyphae from young cultures on potato dextrose agar were used for inoculation and the inoculated plants were incubated in moist chambers for 24 hours. Indications of successful infection on *Cyperus compressus* and *Commelina benghalensis* became evident after 15 days.

Cross inoculation experiments were carried out by inoculating *P. oryzae* on *Cyperus compressus* and *Commelina benghalensis* in a glass house at Mahabaleshwar (4,000 ft). during the month of August, when conditions for epiphytotic with *P. oryzae* are most favourable. While on rice plants, *P. oryzae* incited 100 percent infection causing severe blotching, none of *Cyperus compressus* and *Commelina benghalensis* plants became infected. Though *P. oryzae* is somewhat morphologically similar to the fungus on *Commelina benghalensis*, both do not cross–inoculate.

Discussion

The genus *Piricularia* was established by Saccardo (Michelia II, page 20, 1880) with the type species *P. grisea* (Cke.) Sacc. which was previously described under the name *Trichothecium griseum* Cke. The chief hosts for this species were *Digitaria sanguinalis*, *Setaria viridis* and *S. italica*. *Piricularia oryzae* described later by Cavara (Fungi Longob. Exsicc. n. 49, 1892 in Atli. Instit. bot, Pavia 2 ser. III, 280, 1892) is considered by many workers to be indentical with *P. grisea* though from the original descriptions, the spores of *P. oryzae* are slightly broader (10–12μ as compared with 7–9μ in *P. grisea*). In describing the conidiophores and conidia, Saccardo himself stated that they are hyaline to pale greyish in colour, but still included the genus under Moniliaceae. A detailed study of *P. oryzae*, *P. grisea* on several hosts, *P. higginsii* var. *poonensis* and *P. oryzae* var. *commelinae* both from naturally infected plant material as well as from artificial cultures, indicate that *Piricularia* must be included under Dematiaceae along with *Helminthosporium*. The conidiophores in all the cases are subhyaline to pale olivaceous and are comparable to those of *Cercospora*. The same characters which separate *Cercospora* from *Cercosporella* make us to consider *Piricularia* as a member of Dematiaceae. In artificial cultures, the mycelium is at first hyaline later turning grey to fumaceous. In *P. higginsii* var. *poonensis*, the large black sclerotia comparable to those produced by *Macrophomina phaseoli* are characteristic of a member of Dematiaceae only.

Pimpri, Poona
and
Agricultural College, Poona.

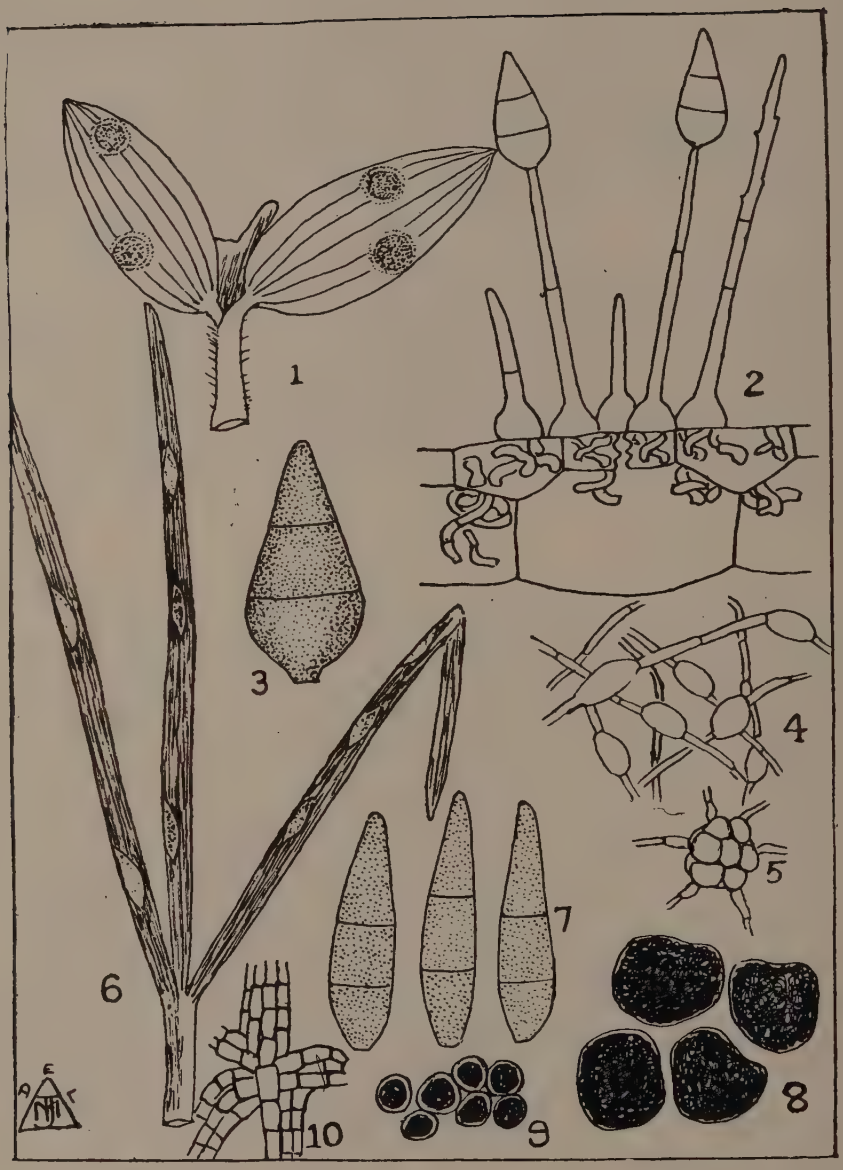
EXPLANATION OF FIGURES

Figs. 1—5. *Piricularia oryzae* var. *commelinae.*

(1) Infection spots on *Commelina banghalensis*
(2) Conidiophores and conidia
(3) Conidium
(4) Swollen cells of the hyphae
(5) Hyphal knots on PDA

Figs. 6—10. *Piricularia higginsii* var. *poonensis*

(6) Lenticular infection spots on *Cyperus compressus*
(7) Spores
(8) Sclerotia on Moyer's agar
(9) Chlamydospore–like cells of sclerotia
(10) Fasciculate hyphae produced in culture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*NOTES ON MISCELLANEOUS INDIAN FUNGI - III

B. L. Chona and R. L. Munjal

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39. *Mycosphaerella phaseoli* sp. nov. (Fig. 1)

Perithecial stage:

Perithecia scattered, globose, black, at first innate, then erumpent, ostiolate, amphigenous, mostly epiphyllous; 105–126μ in diameter (mostly 112–122μ); wall parenchymatic in texture, 3–4 layered thick, hyaline within, supporting asci on short papillate outgrowths from basal cells; Ostiole prominent, central, circular, 28–35μ diameter, cells of the ostiole smaller and darker than those of the perithecial wall. *Asci* fasciculate, cylindric–clavate, sessile, aparaphysate, hyaline with slight bluish tinge, 8 spored, 40–52 x 6–7μ, rarely 45–60μ, with thick, hyaline wall. *Ascospores* hyaline, bicelled, rounded above, slightly tapering below, broader in the middle, rarely constricted at septum, upper cell smaller, lower one larger, 8–14 x 3–4μ (mostly 10–11 x 3.5μ).

In necrotic spots on leaves and stem of *Phaseolus aureus* Roxb, Saproon Valley, Simla Hills, September, 1953 (R.N. Azad).

Conidial stage:

Lesions on leaves irregular, angular in outline, somewhat elliptic on stem and pods, measuring 2–11 mm. in diameter, liver brown to vandyke brown in colour, later tawny and even olivaceous gray due to the appearance of sporophores and spores (this superficial olivaceous tinge is evanescent). *Conidiophores* come out of stomata forming a dense mat of olivaceous hyphae both on upper as well as lower surface; mostly on the under surface; in bundles of 3 to 4, without any sclerotial formation of stromata at the base; pale to dark olivaceous brown, straight below, divergent above, multiseptate, 2–4 geniculate, not branched, uniform in width, medium dark brown, getting lighter in colour towards apex, usually with a medium spore scar at the subtruncate tip, 4–6 x 60–140μ. *Conidia* acicular, straight or slightly curved, hyaline, sometimes with an olivaceous tinge, truncate, subacute tip, multiseptate, sometimes constricted at the septum, 3–5 x 36–120μ.

On leaves, stem and pods of *Phaseolus aureus* Roxb., Saproon Valley, Simla Hills, August–September, 1953 (R.N. Azad).

Mycosphaerella phaseoli spec. nov.

Status perithecialis: Perithecia dispersa, globosa, nigra, primo innata, tum erumpentia, ostiolata, amphigena, ut plurimum epiphylla, 105–126μ diam. (ut plurimum 112–122.5μ); parietes parenchymatici textura, 3–4

* Series I & II appeared in *Indian Phytopathology* Vol. 3, No. 1, 1950, and Vol. 8, No. 2, 1956, respectively. Type specimens of the new species have been deposited at Herb. Crypt. Ind. Orient., I. A. R. I., New Delhi.

cellularum serie crassi, intus hyalini, supportantes ascos insidentes papillis brevibus cellulis basalibus,; ostiolum prominens, centrale, circulare, 28-35μ. diam., eius vero cellulae minores atque plus fuscae quam cellulae parietales perithecii. *Asci* fasciculati, cylindrici, clavati, sessiles, aparaphysati, hyalini sed diffuso caeruleo colore tincti, octospori, 40–52 x 6–7μ raro 45–60 x 6–9μ, parietibus hyalinis crassis. *Ascosporae* hyalinae, bicellulatae, rotundatae supra, tenuiter fastigatae infra, latiores ad medium, raro constrictae ad septum, cellula superiore minore, inferiore veri largiore, 8–14 x 3–4μ (ut plurimum 10–11 x̄ 3.5μ).

Habitat in maculia necroticis foliorum atque culmorum *Phaseoli aurei* Roxb., typus lectus in Valle Saproon, in montibus ad Simla, mense septembri anni 1953 a R.N. Azad.

Status conidialis: Laesione foliorum irregulares, ambitu angulares, aliquantum ellipticae in culmis atque fructibus, plus minusve circulares in foliis, 2–11 mm. diam., "Liver Brown" and "Vandyke Brown" colore, tum fulvae vel etiam olivaceo-griseae ob praesentiam sporophororum atque sporarum (haec tamen tinctio olivacea superficialis evanescit). *Conidiophori* emergunt ex stomatibus ut tegeticula densa hypharum olivacearum in utraque pagina foliorum, sed praecipue in inferiore pagina, terni vel quaterni, absque ulla sclerotica structura ad basim, pallide vel fusce olivaceo-brunnei, ut plurimum recti sed divergentes supra, multiseptati, 2–4–geniculati, haud ramosi, uniformes latitudine, ad medium fusce brunnei, aliquantum pallidiores ad apicem, ut plurimum ornati cicatrice media sporae ad apicem subtruncatum, 4–6 x 60–140μ. *Conidia* acicularia, recta vel tenuiter curvata, hyalina, aliquando olivacee tincta, truncata ad basim, subacuta ad apicem, multiseptata, nonnumquam constricta ad septum, 3–5 x 36–120μ.

Typus in foliis, culmis atque fructibus *Phaseoli aurei* Roxb. in valle Saproon, in montibus ad Simla, mense Augusto–Septembri anni 1953 a R.N. Azad.

The above description of conidial stage agrees with *Cercospora kikuchii* Matsumoto and Tomoyasii, recorded earlier on *Glycine max* Merr. only (*Annals Phytopath. Soc. Japan*, **1** (6) : 10, 1925).

The fungus was found doing heavy damage to the crop. Although no organic connection has been established between the ascigerous and conidial stages, the presence of both in the same spots and also the fact that some perithecia were often seen bearing conidiophores resembling those of *Cercospora kikuchi* suggest that these are two stages of the same fungus.

We have seen records of *Mycosphaerella cruenta* (Sacc.) Latham (*Mycologia*, **26** (6): 525–526, 1934) on this host but the present species differs from it in having bigger perithecia, broader ostiole and smaller size of ascospores.

40. *Scolecodothis phoenicis* sp. nov. (Fig. 2)

Stromata linear, coalescing, irregular, black, erumpent, 3–5 x 0.5–1 mm.

Perithecia embedded in host tissue, opening by an ostiole, covered by an epidermoid shield, single or many in one stroma, carbonaceous, lenticular to conical with distinct wall, 180–300 x 105–180μ (mostly 210–240 x 120–135 μ); Wall parenchymatous, many layered. *Asci* fusoid, clavate, sessile, 8 spored, 49–63 x 14–21 μ. *Ascospores* fusoid, curved, lunate to falcate, single celled, ends blunt, many oil globules present giving the appearance of false septa, 45–60 x 3.5–5μ. *Paraphyses* simple, curved, numerous, 70–105 x 2–3.5 μ with many oil droplets.

On dead leaf stalk of *Phoenix* sp., Hinden Nadi, Delhi, 24.12.1954 (G. Lall).

Scolecodothis phoenicis spec. nov.

Stromata linearia, coalescentia, irregularia, nigra, erumpentia, 3–5 x 0.5–1 mm. *Perithecia* immersa in textus plantae hospitis, pantentia per ostiolum, operta scuto epidermioideo, singula vel plura in singulis stromatibus, carbonacea, lenticularia vel conica, oranta parietibus distinctis, 180–300 x 105–180 μ (ut plurimum 210–240 x 120–135 μ). Parietes parenchymatici, pluries seriati, crassi. *Asci* fusiformes, clavati, sessiles, octospori, 49–63 x 14–21 μ. *Ascosporae* fusiformes, curvatae, lunatae vel falcatae, unicellulatae, apicibus hebetibus, continentes plures globulos olei qui causa sunt cur ascosporae falso septatae videantur. Paraphyses simplices, curvatae, plures, 70–105 x 2–3.5μ pluribus olei globulis ornatae.

Typus lectus est in petiolo emortuo speciei cuiusdam *Phoenicis* in loco Hinden Nadi, prope, Delhi, die 24 decembris anni 1954 a G. Lall.

41. *Sphacelotheca panjabensis* Sydow apud Sydow and Ahmad in *Ann. Mycol. Berl.*, **37**: 442, 1939.

In the ovaries of *Cenchrus setigerus* Vahl. and *C. ciliaris* L., Indian Agricultural Research Institute, New Delhi, 1.10.1952 (R.L. Munjal).

This fungus has earlier been recorded from Sargodha, West Punjab, now a part of Pakistan.

42. *Ustilago bromivora* (Tul.) Fisch de Waldh. in *Bull. Soc. Imp. Nat. Moscou*, **40**: 252, 1867, Saccardo, *Syll. Fung.* **4**: 461, 1888, Cifferi in *Flora Italica Crypt., Fascicolo* No. 17 : 297, 1938.

In the ovaries of *Bromus catharticus* Vahl. (=*Bromus unioloides* H.B.K.), Indian Agricultural Research Institute, New Delhi, 2.5.1950 (R.L. Munjal), Wheat Breeding Substation, Tutikandi, Simla, 24.5.1953 (R.N. Azad).

The disease was first observed at the I.A.R.I., New Delhi, destroying 70–80% plants in Uruguay (South America) collection and has since been appearing regularly every year. As *Bromus catharticus* grows over a vast area in India, the danger of this smut establishing itself in India cannot be ruled out.

43. *Ustilago lorentziana* Thuem. *F. aus Entre Rios* in *Flora*, **63** : 30, 1880; Saccardo in *Syll. Fung.*, **7** : 462, 1888.

In ovaries of *Hordeum stenostachya* Godr., Botanical area, Indian Agricultural Research Institute, New Delhi, 4.6.1949 (G. Lall).

44. *Ustilago tritici* (Pers.) Rostrup in *Overs. danske vidensk. Selsek. Forh.* 1890; Saccardo in *Syll. Fung.*, **9** : 1891; Humphrey and Tapke in *Phytopath.*, **15** : 598–606, 1925.

In the floral parts of *Secale cereale* L., Wheat Breeding Substation, Tutikandi, Simla, (May, 1952, R.L. Munjal).

Only a few ears were found infected which showed typical symptoms of loose smut of wheat. The brand spores found on rye resemble those of *Ustilago tritici* in their morphology and mode of germination. Furthermore, Humphrey & Tapke (1925) have shown that *U. tritici* easily infects rye. This fungus is, therefore, identified as *U. tritici* (Pers.) Rostrup. *Ustilago nuda* (Jens.) Rostrup and *U. tritici* (Pers.) Rostrup are morphologically alike and the former has nomenclatural priority over the latter; but on account of the long usage of the name *U. tritici* and its great importance in plant pathology, we feel that this name should be conserved and have, therefore, preferred to call the fungus under study as *U. tritici*.

45. *Puccinia calthae* (Grev.) Lk., in Willd., *Sp. Pl.* **6** : 79, 1825; Saccardo in *Syll. Fung.* **7** : 602, 1888; Sydow in *Mon. Ured.* **1**: 540; Arthur in *Manual of Rusts in United States and Canada*, 1934.

On leaves of *Caltha palustris*. L. var. *normalis*, Rotang pass, Kulu Division, Kangra, July, 1954 (L.M. Joshi).

This is an autoeceous rust. The fungus forms yellow coloured aecia, which are in groups both on upper as well as lower surface of the leaf though mostly on the lower one. The aeciospores are globoid and measure 15–18 x 17–21 μ.

46. *Puccinia rubigovera* (DC) Wint., in *Rab. Krypt. Fl.* **1** : 217, 1881; Arthur in *Manual* of *Rusts in the United States and Canada*, 1934.

On leaves of *Thalictrum species*, Kote, Keylong (Lahaul Valley), Kulu Division, Kangra, 21.6.1954 (L.M. Joshi).

This is a heteroeceous rust. Only pycnial and aecial stages were observed on this host. The fungus completes its life cycle on certain graminaceous hosts. The size of aeciospores met with in this case agrees with that of *P. rubigovera agropyri*, but we do not consider it justified to call it so without conducting cross inoculation tests.

47. *Phyllosticta delhiensis* sp. nov. (Fig. 3)

Spots almost round, 2–3 mm. in diameter, occurring singly, very rarely two together and then becoming irregular in outline, cartridge buff

with raised bister coloured margin, studded later with black dots. *Pycnidia* subepidermal, innate, later erumpent, amphigenous, mostly epiphyllous, scattered, dark brown, globose or subglobose, measuring 80–120 x 70–90 μ in diameter; ostiolate; ostiole slightly protruding, circular, 20–25 μ in diameter, cells of ostiole smaller and darker in colour than those of the pycnidial wall; outer layer of wall, parenchymatic, cells measuring 10–11 x 6–7 μ. *Pycnospores* round to oval, hyaline, continuous, thick walled, 6–12 x 6–9 μ, round ones mostly 6–8 μ, a few even appearing as pyriform, borne singly on hyaline, single celled, cylindrical, conidiophores (obtuse angled above), measuring 14–18 x 3.5 μ.

On living leaves of *Capparis sepiaria* L., Mandir Lane, New Delhi. 22.7.1954 (R.L. Munjal), Type.

Phyllosticta delhiensis spec. nov.

Maculae fere circulares, 2–3 mm. diam., singulae, separatae, raro binae tumque evadentes irregulares ambitu, colore "Cartridge buff", circumdatae margine elevato, speciaceo, postea distinctae punctis nigris. *Pycnidia* subepidermalii, innata, tum erumpentia, amphigena, ut plurimum epiphylla, dispersa, fusce brunnea, globosa vel subglobosa, magnitud. 80–120 x 70–90 μ, ostiolata; ostiolum breviter prominens, circulare, 20–25μ. diam.; cellulae ostioli minores atque colore profundiores quam cellulae parietales pycnidii praedita perietibus parenchymaticis (parietum cellulis 10-11 x 6–7 μ magnitud.), *Conidia* globosa vel ovata, hyalina, continua, crassis parietibus praedita, 6–12 x 6–9 μ, globosa quidem ut plurimum 6-8μ, nonnulla etiam pyri-formia, insidentia singula conidiophoris hyalinis, unicellulatis, cylindricis (obtuse angulatis supra), magnitudinis 14–18 x 3.5 μ.

Typus lectus in foliis viventibus *Capparidis sepiariae* Linn. in loco Mandir Lane, in urbe New Delhi, die 22 julii anni 1954 a R.L. Munjal.

Three species of *Phyllosticta* have been recorded on *Capparis* sp. so far, namely *P. capparidicola* Speg., *P., capparidearum* Speg. and *P. capparis-heyneanae* DaCosta & Mundkur. The fungu described above differs from these three in having bigger spores and pycnidia as also in producing distinct spots on the leaf.

48. *Selenophoma eugenial* sp. nov. (Fig. 4)

Pycnidia formed on indefinite spots, innate, later erumpent, subepidermal, mostly single, scattered, globose or pitcher shaped, carbonaceous, leathery, measuring 98–210 x 98–182μ in diameter, ostiolate; ostiole prominent and protruding , 21-28 μ (mostly 25 μ) in diameter, outer wall of the pycnidium parenchymatous, many layered, measuring 14–21 x 11μ. *Pycnospores* hyaline, single celled, fusoid, ends acute, straight or slightly curved, bulging on one side, mostly lunate. Conidophores not seen.

On dead leaves of *Eugenia operculata* Roxb., Indian Agricultural Research Institute, New Delhi, Jan. 1951. (R.L. Munjal), Type.

Selenophoma eugeniae spec. nov.

Pycnidia in maculis indefinites, innate, postea erumpentia, subepidermalia, ut plurimum singula, dispersa, globosa vel urceolata, carbonacea, coriacea, magnit. 98–210 x 98–182μ diam., ostiolata; ostiolum prominens atque protrussum, 21–28 μ (ut plurimum 25 μ)diam., parietum cellulis parenchymaticis, pluries seriatis, magnitud. 14–21 x 11μ *Pycnosporae* hyalinae, unicellulatae, fusiformes, apicibus acutis, rectae vel aliquantum curvatae, uno latere tumescentes, ut plurimum lunatae 15–19 x 3 μ. Conidiophori ignoti.

Typus lectus est in foliis emortuis *Eugenia operculata* Roxb. in Indian Agric. Res. Instit., in urbe New Delhi a R. L. Munjal.

49. *Ceuthospora litchii* sp. nov. (Fig. 5)

Spots irregular, epiphyllous, raised, buff pink to start with, later snuff brown, changing to light drab and light greyish olive, corresponding area on the undersurface furnished with blackish brown velvetty superficial outgrowth, 16–28 x 10–24 mm. *Pycnidia* epiphyllous, innate, subepidermal, borne in valsoid type of stroma, appearing as locules. Loculus round or slightly irregular, opening by a common pore, 180–230 x 77–90 μ. *Spores* hyaline, elliptic, with both ends rounded, single celled, 7–9 x 3–3.5 μ, borne on short, single celled, hyaline, conidiophores narrowed above and measuring 5–7 x 2–3 μ.

On living leaves of *Litchi chinensis* Sonner, Mohammada, Pusa, Bihar, March, 1949 (R. L. Munjal), Type.

Ceuthospora litchii spec. nov.

Maculae irregulares, epiphyllae, elevatae, primo bubalino-roseae, tum snuff brown, tandem luteolo-griseae vel pallide griseo-olivaceae; partes foliorum in inferiore pagina maculis oppositae ornatae structura superficiali serica, 16–28 x 10–24 mm. *Pycnidia* epiphylla, innata, subepidermalia, insidentia, stromati valsoideo, apparentia ut loculi; loculus rotundus, vel tenuiter irregularis, patescens per porum communem, 180–230 x 77–90μ. *Sporae* hyalinae, ellipticae, rotundatae ad utrumque apicem, unicellulatae, 7–9 x 3–3.5μ, insidentes conidiophoris tenuis unicellulatis, hyalinis, supra angustatis, magnit. 5–7 x 2–3 μ.

Typus lectus est in foliis viventibus *Litchi chinensis* Sonn. in loco Mohammada, Pusa in provincia Bihar, mense martio anni 1949 a R.L. Munjal.

The fungus is associated with a severe leafcurl disease of *litchi*. The affected spots are variously curved though mostly these are convex on the upper surface and concave on the under surface, giving rise to cavity formation. On the undersurface, there is velvetty superficial outgrowth, which under the microscope appears as elongated cells. The disease is of great economic importance. The cause of the trouble is attributed to mite attack but the constant association of this fungus in the diseased spots calls for the study of its role in the causation of disease. The mycelium is intercellular, hyaline and septate. The stromata develop between the

epidermis and the palisade cells resulting in disorganisation and destruction of the latter. The pycnidia develop as small loculi in the stroma. They are leathery in texture and their wall is many layered. They are globose to start with but many become discoid or irregular in shape due to the pressure of other loculi developing in the same stroma, and open by a common pore by rupturing the epidermis. In one case, ascigerous stage, which agreed with *Trematosphaeria* was also observed but as the material of the ascigerous stage collected by us is too scanty to allow any detailed study, its description is not given here.

50. *Septoria dolichi B. & C.* in *North. Amer. Fungi* n. 449, Sacc. in *Syll. Fung.* **3** : 509, 1884.

Spots usually roundish, a few irregular, at first tan coloured with raised broad dark brown margin, later the centre of spots turns grey due to the appearance of fructifications, and measuring 4–9 mm. in diameter. *Pycnidia* amphigenous, mostly epiphyllous, gregarious in the centre of spot, globose or subglobose, innate–erumpent, dark brown, seated in the mesophyll tissue and covered by epidermis, thin walled, ostiolate, measuring 98–123 x 90–112 μ. Ostiole measuring 30–35 μ in diameter. *Spores* hyaline, straight or somewhat curved, 1–3 septate, one end acute and other rounded, 28–40 x 2.5 μ (mostly 32–35 x 2.5 μ), borne on short elliptic, hyaline cells of the pycnidial wall.

In living leaves of *Dolichos lablab* Linn., Sholada, Anikori Valley, Nilgiris, 12.12.1951, (R. L. Munjal).

The fungus causes a severe leaf spot disease, resulting in shot holes and ultimate drying up of the leaves. The description of the fungus, as given by its authors, is too meagre; as such a fuller account is presented here. The breadth of spores observed by us is less than that given in the original description, but this difference could be attributed to natural variation within a species.

51. *Septoria macropoda* Pass.var. *septulata* (Grouz. Frag.) Sprague in *Phytopath.* **32** : 737–738, 1942.

On living leaves of *Poa* sp. (Gramineae), Ootacamund, Nilgiris. 15.12.1951 (R. L. Munjal).

52. *Gloeosporium eugeniae* sp. nov. (Fig. 6)

Spots circular or slightly irregular, zonate, Drab coloured, 18–27 mm. in diameter, delimited by leaf midrib, usually single and scattered, rarely coalescing. *Acervuli* epiphyllous, separate, few, discoid, subepidermal formed above the palisade tissues; stroma linear, 2–3 layered thick, hyaline, measuring 161–203 μ in diameter. *Conidiophores* hyaline, slender, slightly pointed above, 12–19 x 3μ. *Conidia* hyaline, elliptic, slightly curved, 8–16 x 2.5–3.5μ (mostly 12–15 x 3–3.5 μ), vacuolate with a central prominent oil drop giving the appearance of a false septum.

On living leaves of *Eugenia operculata* Roxb., Indian Agricultural Research Institute, New Delhi, 24.7.1954 (R. L. Munjal), Type.

Gloeosporium eugeniae spec. nov.

Maculae circulares vel paulisper irregulares, zonatae, v ravae, 18–27 mm. diam., definitae nervo medio, ut plurimum singlae et separatae, raro coalescentes. *Acervuli* epiphylli, separati, rari, disciformes, subepidermales, efformati supra textus vallares; stroma lineare, 2–3 seriatum, hyalinum, magnit. 161–203 μ diam. *Conidiophori* hyalini, tenues, paulisper acuti supra, 12–19 x 3 μ. *Conidia* hyalina, elliptica, tenuiter curvata, 8–16 x 2.5–3.5 μ. ut plurimum 12–15 x 3–3.5 μ vacuolata, ornata globulo olei centrali prominenti qui falsum septum fingit.

Typus lectus in foliis viventibus *Eugeniae operculatae* Roxb. in I.A.R.I. New Delhi die 24 julii anni 1954, (R. L. Munjal).

53. *Gloeosporium sundari* sp. nov. (Fig. 7)

Spots indefinite; *Acervuli* subepidermal, for a long time remaining covered, then erumpent, separate, scattered, numerous, black, dot like measuring 220–250 x 80–100 μ. *Conidia* hyaline, single celled, with two big vacuoles occupying the entire cavity, cylindrical, both ends rounded or a few slightly pointed towards apex, measuring 9–11 x 3.5μ, borne singly on single celled, hyaline, conidiophores pointed above and measuring 11–15 x 3.5–4.5 μ.

On drying twigs of *Rosa* sp., Sundar Nursery, Nizamuddin, New Delhi, 22.2.1955, (R. S. Vasudeva and R. L. Munjal) Type.

Gloeosporium sundari spec. nov.

Maculae indefinitae; *Acervuli* subepidermales, diu operti remanentes, tum erumpentes, separati, dispersi, plures, nigri, punctis similes, magnitud. 220–250 x 80–100 μ *Conidia* hyalina, unicellulata, duplici vacuolo totam cavitatem occupante, cylindrica, rotundata ad atrumque apicem, vel nonnulla fastigata ad superiorem apicem, magnit. 9–11 x 3.5 μ, singula insidentia conidiophoris, unicellulatis, hyalinis, acutis, supra et magnit. 11–15 x 3.5–4.5 μ.

In ramulis siccans speciei cuiusdam *Rosae*, in loco Sundar Nursery, Nizamuddin, New Delhi, die 22 februarii anni 1955; R. S. Vasudeva et R. L. Munjal.

54. *Circinotrichum thevetiae* sp. nov. (Fig. 8)

Spots sooty, elongate, mostly scattered, rarely coalescing, measuring 3–5 x 2–3 mm. bearing erect, sterile hyphae, repeatedly dichotomously branched, dark brown, contents granulose, 600–715 μ high, branches arcuate. *Spores* hyaline, single celled, falcate with blunt ends, 8–11 x 2–2.5μ (mostly 9–10 x 2.5 μ), borne singly on conidiophores forming a hymenial layer. *Conidiophores* short, hyaline single celled, pointed above, measuring 5–6 x 1.5–2 μ.

On dead twigs of *Thevetia nerifolia* Juss., Ridge Road, New Delhi 8.6.1950 (R. L. Munjal), Type.

Circinotrichum thevetiae spec. nov.

Maculae fuligineus, linearis, plurimum dispersi, raro coalescentes magnitud. 3–5 x 2–3 mm. gerenae hyphae steriles erectae, iterum iterumque dichotome bifurcatae, fusce brunneae, contentis granulosis, 600–715μ altae, ramis arcuatis. *Spores* hyalinae, unicellulatae, falcatae apicibus hebetibus, 8–11 x 2–2.5 μ (ut plurimum 9–10 x 2.5 μ) singulae insidentes conidiophoris qui efformant seriem hyenialem. *Conidiophori* hyalini, unicellulati, acuti supra, breves, magnitud. 5–6 x 1.5–2 μ.

In surculis emortuis *Thevetiae nerifoliae* Juss., typus lectus est ad Ridge Road, in urbe New Delhi, die 8 aprilis 1954 a R. L. Munjal.

55. *Chaetostroma atrum* Sacc. in *Michelia* **2** : 174, *Syll. Fung.* **4**: 749, 1886.

On drying leaves of *Dicanthium annulatum* (Forsk.) Stapf, Botanical area, Indian Agricultural Research Institute, New Delhi, 14.10.1954, (R.L. Munjal).

The fungus forms sporodochia, which appear as black dot like structures on both the surfaces of leaves. The fructifications are superficial, plano-pulvinate and are interspersed by two types of setae, the longer and smaller ones. Longer ones are few, septate and measure 136–190 x 6–7 μ, while smaller ones are numerous, forming a thick outer cover, continuous, measuring 70–84 x 4–5 μ. The *conidiophores* are numerous, packed together into a cushion–like structure, hyaline, filiform with granular protoplasmic contents, continuous, bear conidia singly at their tips and measure 8–10 x 1.5 μ. *Conidia* are hyaline and cylindrical when young, bluntly fusoid and olivaceous when mature, dark enmasse, continuous, 11–13 x 2–3 μ and devoid of oil drops.

56. *Alternaria tenuis Auct in Wiltshire*

Neergard, P. in Danish species of *Alternaria* and *Stemphylium*, 1945.

Syn. *A. tenuis* Nees in *Syst. d. Pilze u Schwamme*, p. 72, 1817.

A. fasciculata (Cke. & Ell.) Jones & Grout in *Bull. Torrey Bot. Club*, **24** : 257, 1897.

On living leaves of *Lawsonia alba* Lamk., Hauz Khas, New Delhi. 21.2.1954 (R.L. Munjal).

The fungus forms ashy coloured round spots with raised dark brown margins. The necrotic portion of the spots assumes this colour due to abundant sporulation both on the upper and lower surface of the leaves. The spores are muriform with 2–3 longitudinal and 2–5 cross septa, with beak and measure 20–58 μ in length (including beak).

57. *Helminthosporium ravenelii* Curtis & Berk. in *North. Amer. Fungi* n. 628; Saccardo in *Syll. Fung.* **4** : 412, 1898.

Infecting all the ovaries in the inflorescence of *Sporobolus* sp., Imphal, Manipur, Assam, 27.12.1951 (R. R. Panje).

Apparently resembling smut infection, with agglutinised sooty spore mass.

58. *Gonatorrhodum clerodendri* sp. nov. (Fig. 9)

Conidiophores stout, single or in groups of two to four, straight or slightly curved, swollen at places and thus appearing nodulose, marguerite yellow in colour and aseptate when young, later septate and snuff brown, mostly unbranched, rarely branched, measuring 255–465 x 13–21 μ (mostly 350–450 x 15–18 μ). *Conidia* formed on swollen nodes or at the swollen apex, generally at the latter, on short hyaline sterigmata, in small heads (groups) which measure 55–70 μ in diameter. Conidia borne in short chains in basipetel succession,and connected with each other by short hyaline papillae; ovate, single celled, Cinnamon buff to Russet coloured, measuring 12–14 x 11–12 μ. Wall of the spore warty and 2 μ thick.

On dead twigs of *Clerodendron* sp., opposite Library, Indian Agricultural Research Institute, New Delhi, 31.1.1955 (R. L. Munjal). Type.

Gonatorrhodum clerodendri spec. nov.

Conidiophori validi, singuli, bini, terni vel quaterni, recti vel tenuiter curvati, tumescentes in locis quibusdam atque ita nodulosi apparentes, primo margarite yellow colore nec septati, tum snuff brown, ut plurimum haud ramosi, raro ramosi, 255–465 x 13–21 μ (ut plurimum 350–450 x 15–18 μ) magnitudine. *Conidia* efformata in nodulis tumescentibus, vel in apice tumescente, ut plurimum in ultimo, insidentia sterigmatibus brevibus hyalinis quae capitula parva efficiunt magnitudinis 55–70 μ diam. *Conidia* catenulata catenulis brevibus successione basipetali, atque inter se papillis brevibus hyalinis connexa, ovata, unicellulata, cinnamomobubalina vel fusca colore, magnitudinis 12–14 x 11–12μ. Sporarum parietes verrucosi atque 2 μ crassi.

In surculis emortuis *Clerodendri*, a regione Bibliothecae, Indian Agric. Res. Inst., New Delhi, 31 Jan. 1955 (R.L. Munjal), Typus.

In the young conidiophores, hardly any nodular or swollen structure is found which shows clearly that the conidia are formed in small heads at the swollen apex of conidiophores on short hyaline sterigmata. Later this swollen apex proliferates and the stalk of the conidiophores grows further and forms another swollen apex, thus giving the conidiophores the appearance of being nodulose.

Our grateful thanks are due to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology, for his keen interest, helpful criticism and providing necessary facilities for work. We also thankfully record the help of Rev. Father Dr. H. Santapau, Chief Botanist, Botanical Survey of India, Calcutta, for rendering the latin diagnosis of new species.

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EXPLANATION OF PLATES

Fig. 1. *Mycosphaerella phaseoli*
a. Perithecium
b. Ascospores

Fig. 2. *Scolecodothis phoenicis*
a. T.S. through leaf stalk showing perithecia
b. Ascus and Ascospores

Fig. 3. *Phyllosticta delhiensis*
a. T.S. through leaf showing pycnidia
b. Pycnidium

Fig. 4. *Selenophoma eugenii*
a. Pycnidium
b. Pycnospores

Fig. 5. *Ceuthospora litchii*
a. T.S. through leaf showing pycnidia

Fig. 6. *Gloeosporium eugeniae*
a. Diseased leaf showing typical symptoms
b. Acervulus with conidiophores and conidia

Fig. 7. *Gloeosporium sundari*
a. Acervulus with conidia and conidiophores

Fig. 8. *Circinotrichum thevetiae*
a. Spores

Fig. 9. *Gonatorrhodum clerodendri*
a. Conidiophores bearing conidia
b. Conidium

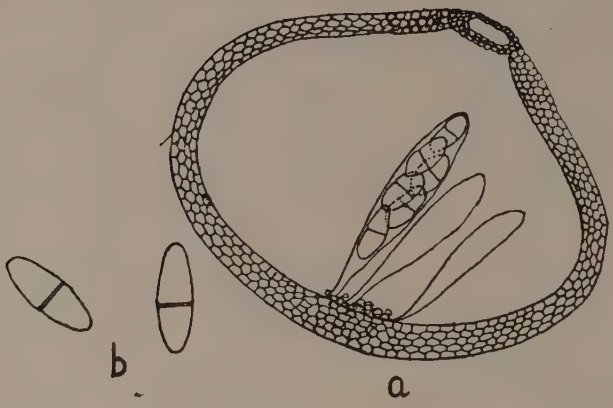
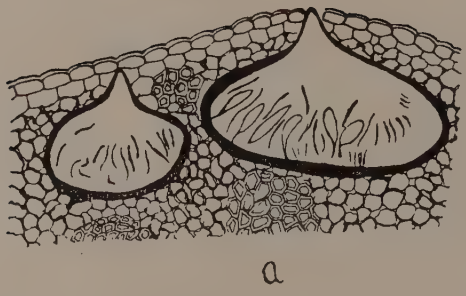


Fig. 1



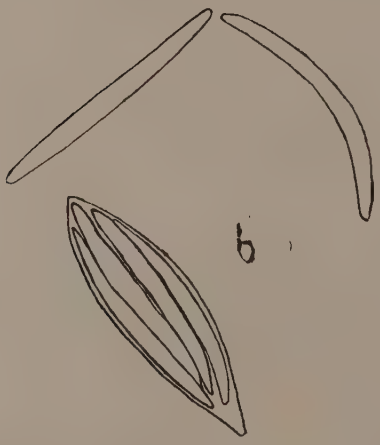


Fig. 2

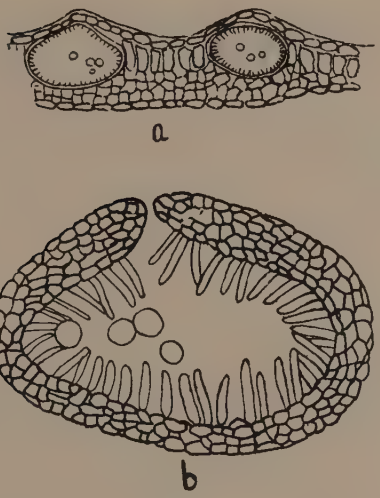


Fig. 3

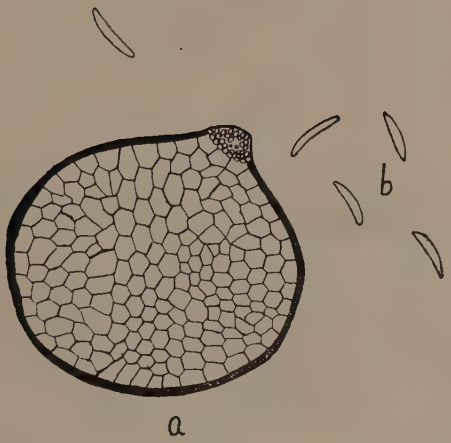


Fig. 4

Fig. 5

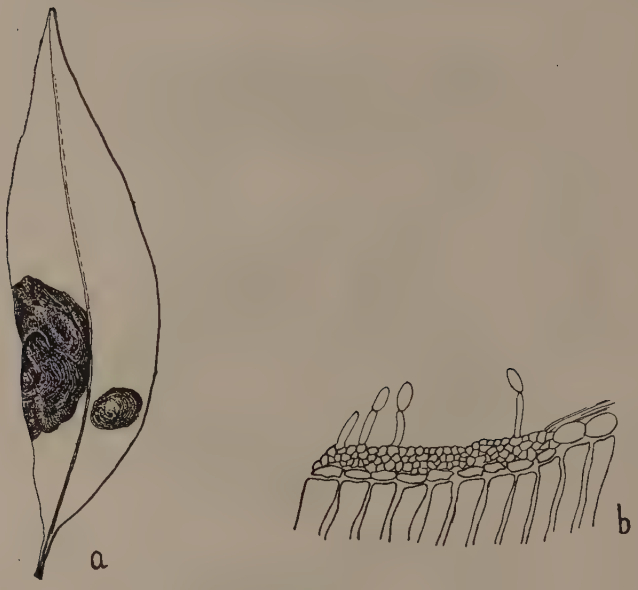


Fig. 6

Fig. 7

Fig. 8

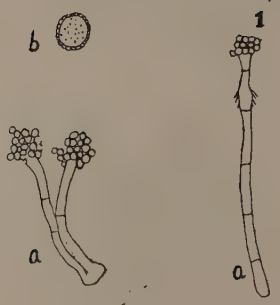


Fig. 9

BACTERIAL BROWN ROT OF POTATOES IN INDIA

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Introduction

Bacterial brown rot or wilt disease of potatoes, *Pseudomonas solanacearum* E. F. Smith, commonly known as "Ring" (*bangdi*) disease or "Bangle blight", has been known in India for many years (Cappel, 1892). Cunningham (Butler, 1903) and Mollison (1901) considered it to be a fungoid disease, but Coleman (1909) established its bacterial nature. Prior to this, Butler (1903) had suggested that the disease might be similar to the bacterial wilt (*Bacillus solanacearum*) of solanaceous plants, described by Smith (1896) in the United States, but he did not carry out infection experiments with the bacterium observed.

The characteristic symptoms of the disease are wilting, stunting and yellowing of the foliage followed by collapse of the affected plants. Browning of the xylem in vascular cells takes place and is often visible from the surface of infected stems as dark patches or streaks. Tubers from the diseased plants show a brown ring in the vascular tissue, and blackening of eyebuds in a severely decayed potato is an important diagnostic symptom. If the infected stems or tubers are cut across and squeezed, greyish–white bacterial ooze comes out of the vascular ring.

The disease has gradually become a problem of increasing importance and the damage caused by it in certain areas seems to be considerable (Mundkur 1949). It has been reported on potato from Bombay (Butler, 1918; Mann and Nagpurkar, 1919, 1921; Patel *et al.*, 1952), Mysore (Coleman, 1909; Butler, 1918), Madras (Butler, 1918; Rajan, 1924; Suryanarayana, 1928; Patel, *et al.*, 1952), Uttar Pradesh (Dey, 1947; Patel *et al.*, 1952), Assam (Sen, 1930; Nandi, 1945), Bihar (Patel *et al.*, 1952) and Bengal (Patel *et al.*, 1952; Mukherji and Chattopadhyay, 1955); on tabacco from Bengal (Hutchinson, 1913 a,b,c; Butler, 1918) and Punjab (Mitra, 1937); and on tomato from Bengal (Hedayetullah and Saha, 1941)*. Galloway (1935) further observed a type of storage rot of potato similar to that caused by *Pseudomonas solanacearum*.

Mehta and Singh (1951) reported another bacterial disease of potatoes from Uttar Pradesh, namely, Ring rot caused by *Corynebacterium sepedonicum* (Spiekermann and Kottof) Skaptason and Burkholder which resembles brown rot disease in symptomatology to some extent. Patel *et al.* (1952), however, think that this disease does not occur in India. It seemed desirable, therefore, to collect diseased material from different potato growing areas with a view to determine whether one or both the diseases occur in the

* On tomato, the disease was observed from Dacca area which is now in East Pakistan.

country. Effect of some environmental factors on infection by the wilt organism was also studied.

Material and Methods

Potato tubers, showing typical brown ring formation, were obtained from Bombay, Mysore, Madras, Bengal, Bihar, Assam, Uttar Pradesh and Punjab. Collections were made from different localities and potato varieties within a State. Since all the isolates from a particular area appeared to be similar, only one isolate from each was taken for a detailed study. Isolates from Bhowali and Ranikhet (Uttar Pradesh), however, slightly differed from one another in that the latter showed a tendency to die out in agarcultures; but in other respects the two cultures were identical. Potato variety *Phulwa*, which had been found to be susceptible in nature, was used throughout the study.

Isolations were made aseptically from the ring portions of cut tubers by the streak method and the cultures purified by the single–colony technique. All the cultures were maintained on 2 per cent. potato-dextrose agar (pH 7.0) and one day old cultures were used for transferring to test media which were then incubated at 80° F. Inoculations were made by removing the plants from soil, washing the roots, and then soaking them in a bacterial suspension for 10 minutes, after which the plants were reset in sterilized soil in pots. Some of the roots were wounded before inoculation.

Experimental Results

Pathogenicity: All the Indian isolates of *Pseudomonas solanacearum* were found to be pathogenic on potato plants and produced typical wilting symptoms within 15 to 20 days at 80° F. Infection was quicker when the roots were injured and then inoculated. Successful infection was also obtained by pouring the bacterial suspension in sterilized soil in pots round the uninjured roots once every week till symptoms of the disease developed, by introducing the organism in the punctured portion of the stem, by dipping the tubers in the bacterial suspension for 15 minutes before planting, and by injecting the pathogen into buds and sprouts of seed–pieces. However, it took longer time (1 to 2 months) for the symptoms to develop by these methods.

None of the isolates was pathogenic on tobacco (var. *White Burley*) and chilli (N.P. 7–1–4) by the root–dipping technique, whereas brinjal and tomato were successfully infected with all the isolates. Patel *et al.* (1952) also did not get infection on chilli and tobacco plants with *Pseudomonas solanacearum*.

The Pathogen: All the isolates were morphologically and culturally similar and agreed with the description of *Pseudomonas solanacearum* as given in the Bergey's Manual by Breed *et al.* (1948). On the basis of physiological differences, however, they could be separated into two distinct groups. Some isolates produced acid in xylose, but not in

cream and litmus milk; others produced acid plus gas in xylose and acid in cream and litmus milk.

Factors Affecting Disease Development: Considerable work has been done on this aspect of the disease in other countries, but, in India, the information available is very meagre (Kelman, 1953). It was thought, desirable, therefore, to study the effect of soil temperature, soil moisture, and age of host plant on infection produced by the Indian organism.

For this study, one isolate from each of the two groups, in which the Indian isolates were classified, was taken up. But the general trend of the results obtained with both the isolates was the same as given below.

Following inoculation, potato plants were held at mean temperatures of 60°, 70°, 80°, 90°, and 100° F. in the controlled soil temperature tanks till the wilting symptoms appeared. No wilting symptoms were developed at 60° F. even after 2 months of inoculation, whereas at 70°, 80°, 90°, and 100° F. the infection was obtained within about 35, 25, 14 and 7 days, respectively.

Effect of soil moisture was studied at 50 % (low), 75% (medium) and 100% (high) water holding capacity by the method followed by Vasudeva (1937), and the wilting symptoms were produced within 30, 19 and 7 days, respectively. Below 50% moisture level, no infection was obtained. The constant temperature of 80° F. was maintained throughout the experiment.

For hydrogen-ion concentration study, nutrient agar was adjusted to pH 4.6, 5.2, 5.6, 6.4, 7.0, 7.6, 8.4, and 9.4 by the colorimetric method and growth observations were recorded after 5 days of inoculation at 80° F. Excellent growth occurred between pH 6.4 to 8.4, moderate at pH 5.6 and 9.4, scanty at pH 5.2 and none at pH 4.6.

In the experiment conducted to determine the effect of age of host on infection, 1, $1\frac{1}{2}$, 2 and $2\frac{1}{2}$ months old potato plants took infection after 20, 27, 38 and 48 days of inoculation, respectively, when kept at the constant temperature of 80° F.

Discussion

From the evidence presented in this paper, it is clear that Ring disease of potato in India is caused by *Ps. solanacearum*, and *Corynebacterium sepedonicum* does not seem to occur in India, since a large number of isolations made from diseased material collected from almost all the potato growing tracts in India failed to yield that organism. It should, however, be the endeavour of every Plant Pathologist to be on the look-out for this pathogen so that early steps may be taken for checking it when observed.

It has, however, been shown that *Pseudomonas solanacearum* var. *asiatica* (E. F. Smith) Stapp, which differs from *Pseudomonas solanacearum*

in its ability to produce acid in cream and litmus milk, is also widely prevalent in the country. Isolates from Punjab, Bombay and Uttar Pradesh generally yielded *Pseudomonas solanacearum*, whereas those from Madras, Mysore, Bengal, Bihar and Assam gave *Pseudomonas solanacearum* var. *asiatica*. Mukherji and Chattopadhya (1955) also reported *Pseudomonas solanacearum* var.*asiatica* on potato from Bengal.

It is further felt that there are probably two or more strains of *Pseudomonas solanacearum* occurring in the country. This is indicated by the fact that the Bhowali and Ranikhet isolates from Kumaon Hills (U.P.,) which were otherwise similar in every respect, differed from one another in that the Ranikhet isolate could not be maintained in artificial culture for long and was ultimately lost. The problem requires thorough investigation before it can be finally settled and the findings so obtained will be of practical importance in breeding resistant varieties.

The disease is favoured by relatively high temperatures and high soil moisture levels. The infection develops rapidly with increase in soil temperature from 70° to 100° F. and with increase in soil moisture from 50% to 100% water holding capacity. It in further obvious that the pathogen grows, at least *in vitro*, over a wide range of H–ion concentration. It has also been observed that there is decrease in disease severity with increase in age of the host plant.

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PHYTOPATHOLOGICAL NOTES

A new species of Protomycopsis on Sesbania aculeata Pers.- J. S. Gupta. During the months of September and October 1950, leaves of *Sesbania aculeata* Pers. growing around Anasagar (lake) in Ajmer, were found to be infected with leaf-galls. The infection first appears as a pale yellow speck, mostly on the under surface of the leaflets. The spots gradually enlarge, turn dark and finally form galls. The galls contain a mass of chlamydospores characteristic of *Protomycopsis*. Three species of *Protomycopsis* are at present known from India, all on members of the Leguminosae. *Protomycopsis Patelii* Pavgi and Thirum. (1953) on *Phaseolus radiatus* and *Protomycopsis crotalariae* Joshi (1955) both produce dark sooty spots with warty exospore. *Protomycopsis smithiae* Thirum. et al on *Smithia sensitiva* produces chlamydospores with convolute to warty wall layer. The present species on *Sesbania aculeata* has thick, reticulate and areolate wall layer, and is therefore quite distinct from other species. While the generic distinction between *Protomycopsis* and *Protomyces* on the basis of wall structure alone may be debatable, the fungus on *Sesbania aculeata*. is placed under *Protomycopsis* on account of similarity with other species parasiting leguminous hosts in India. Following the usual concept of species in obligate parasites, based on the host and spore measurements, a new species of *Protomycopsis* is reported in this note.

Protomycopsis ajmeriensis, Gupta sp. nov.

Gallae in foliis, subnigrae, maxime singulares, crassae globulosae 2–3 mm. diametro. Aliquando gallae coalescunt 4-6 mm. diametro et 1.43–1.97 mm. crassitudine. Mycelium intercellulare, exiguum, breve sed ramosum. Chlamydosporis in mycelio terminales, subnigrae, 21–24μ diametro. Murus reticulatus, areolatus, 3μ crassus.

In *Sesbania aculeata* Pers. sp., Ajmer, 29–9–1950, leg. B. Tiagi, typus.

Galls on leaflets (Fig. 1.), dark brown, mostly isolated, thick, roughly circular, measuring 2–3 mm. in diameter. Sometimes developing galls coalesce forming bigger galls 4–6 mm. in diameter and 1.43–1.97 mm. thick. Mycelium intercellular, scanty, short but branched. Chlamydospore terminal (Fig. 2), dark brown measuring 21–24 μ in diameter. Chlamydospore wall reticulate, areolate and 3 μ thick.

On leaves of *Sesbania aculeata* Pers. Ajmer, 29–9–1950, leg. B. Tiagi, Type.

I am grateful to Professor B. Tiagi, Govt. College, Ajmer for placing the material at my disposal. Thanks are also due to Miss. E. Gibbs of St. John's College, Agra for translating the diagnosis into latin and to Dr. M.J. Thirumalachar for examining a few slides and giving certain suggestions.

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EXPLANATION TO FIGURES

Fig. 1. Infected leaflets showing galls x Nat. Size.

Fig. 2. Host tissue showing mycelium with terminal chlamydospore

Fig. 1.

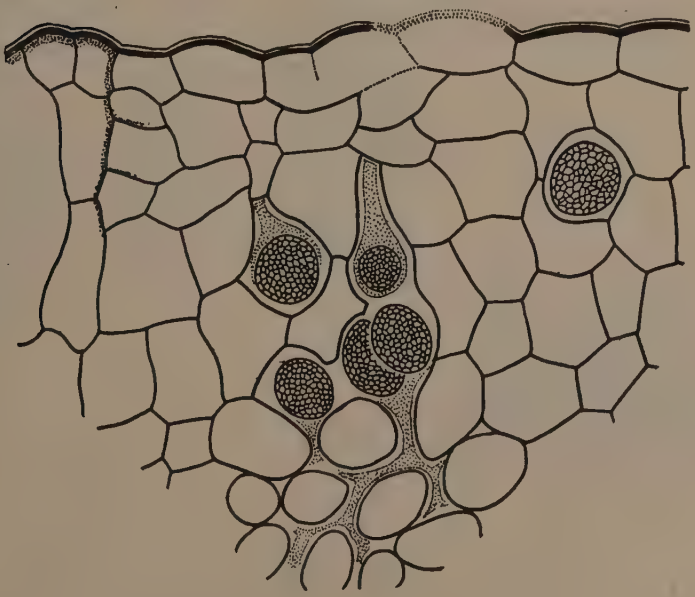


Fig. 2.

Puccinia tumidepes Peck. on Lycium europaeum L. D. D. Dalela

This is a new host record for *Puccinia tumidepes* Peck. Infected leaves of *Lycium europaeum* L. were collected during January–February, 1954 from Adarsh Nagar and adjoining hillocks in Ajmer. The measurements of the uredo and teleutospores of the rust collected corrospond with those of *Puccinia tumidepes* Peck. but the pedicels of the teleutospores are not inflated. The spore measurements have been statistically standardized.

The type specimen (consisting of infected detatched leaves) is deposited in Botany Department, Agra College, Agra and duplicate in the *Herb. Crypt. Ind. Orient.* of Indian Agricultural Research Institute, New Delhi.

Puccinia tumidepes Peck.

Uredosori on both surfaces of leaves, mostly in concentric rings, reddish brown, paraphysate, erumpent and surrounded by ruptured epidermis.

Uredospores ellipsoid, yellow, finely echinulate, with 2 equatorial germ pores, 33.00–41.25μ (mean 36.74μ st. error ±0.429,μ) × 16.50–23.10μ (mean 19.80μ st. error ±0.429μ), stalked, stalk hyaline.

Teleutosori on both surfaces of leaves, mostly in concentric rings, brownish black, paraphysate, erumpent, surrounded by ruptured epidermis.

Teleutospores almost ellipsoid, dark brown, bluntly echinulate, stalked, bicelled, usually with a papillate but sometimes round apex, not constricted at the septum, both the cells of almost equal size, 39.60–47.85 (mean 44.61μ st. error ±0.528μ) × 24.75–29.70μ (mean 27.45μ, st. error ±0.396μ), pedicels firm, persistent, hyaline, upto 36.30μ long.

On leaves of *Lycium europaeum* L. Ajmer, 14.2.1954, leg B. Tiagi, type.

I am grateful to Prof. B. Tiagi, Government College, Ajmer for placing the material at my disposal .

Botany Dept.,

Agra. College, Agra.

EXPLANATION TO FIGURES

1. Infected leaves
2. Uredospores
3. Teleutospores
4. Cross section through a Uredo–teleuto pustule

Fig. 1.

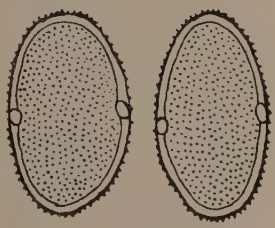


Fig. 2

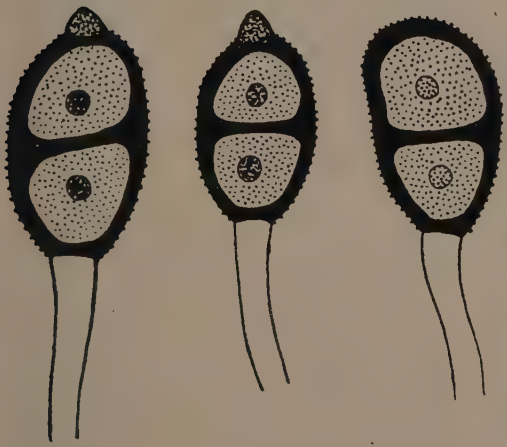


Fig. 3

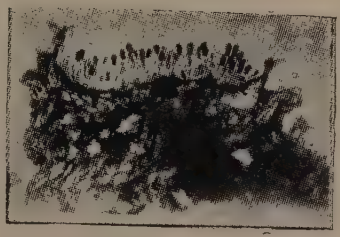


Fig. 4.

Notes on two Fungi from South India.—M. Kandaswamy and N. V. Sundaram

Podosporium thysanolaenae Sp. nov.

Stromata mostly epiphyllous, subcuticular to subepidermal, dark coloured; synnemata made up of closely packed conidiophores, rigid, erect, produced singly, measuring upto 1.26 mm. long and 52 μ broad with capitate apex formed of ramosely branched conidiophores; conidia subcylindric, oblong or elongato-clavate, snuff brown, one to six septate, measuring 62 x 12 μ (29–84 x 9–16).

On living leaves of *Thysanolaena agrostis* Nees. (Gramineae), Coonoor, 17–5–55 (type), M. Kandaswamy and N. V. Sundaram.

Stromata ut plurimum epiphylla, subcuticularia vel subepidermalia, fusca; synnemata composita ex conidiophoris arcte junctis, rigida, erecta, producta singillatim, magnitudinis usque ad 1.26 mm. longa 52μ lata apice capitato composito ex conidiophoris ramose furcatis. Conidia subcylindrica, oblonga vel elongato-clavata, pallide brunnea, semel ad sixies septata, magnitudinis 62 x 12 μ (29–84 x 9–16).

Typus lectus in foliis viventibus *Thysanolaenae agrostis* Nees, e Gramineis, loco Coonoor, die 17 maji, anni 1955, a M. Kandaswamy et N.V. Sundaram.

The infected leaves can be easily identified by the black velvetty growth of the fungus. The infection is confined mostly to the upper surface but in few cases the synnemata were seen on the lower surface also. Sometimes the whole surface of the leaf is completely covered by the growth of the fungus. The synnemata arise from the stromata formed either subcuticularly or subepidermally. The conidiophores at the apex of the synnemata are free and give a fan–like appearance. They may be either branched or simple. One conidium is borne on each conidiophore at the distal end. The spores germinate readily by producing slender germtube from one or more of the cells.

Oidiopsis taurica (Lev.) Salmon

On living leaves of *Verbena bonariensis* Linn. (Verbenaceae), Coonoor, 17–5–55, M. Kandaswamy and N. V. Sundaram.

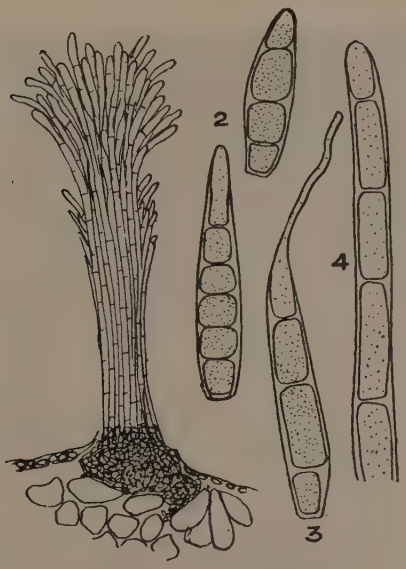
The infected areas can be seen by the yellowish discolouration on the upper surface with whitish growth of the fungus on the corresponding lower surface. The hyphae are intercellular and they come and collect in the sub–stomatal air space from where the conidiophoros arise. One or more conidiophores may come out through each stoma. Sometimes the conidiophores are found branching at the lower half. They are hyaline, septate, rough surfaced and measure up to 300μ long and 9μ broad. Most of the conidia are clavate to cylindrical, hyaline, single–celled with rough surface and measure 54 x 16μ (46–72 x 12–19). A few of the conidia have pointed ends. The characters and the measurements are closely alike that of *Oidiopsis taurica* and hence it is identified as such. This is a new host for this fungus.

The type specimens are deposited in the Herbarium of the Government Mycologist, Coimbatore and in *Herb. Ind. Orient.* I.A.R.I., New Delhi.

We are thankful to Dr. H. Santapau for having kindly translated the descriptions of the new fungus into Latin. Our thanks are also due to the Systematic Botanist and Professor of Botany, Coimbatore for identifying one of the host plants.

EXPLANATION OF PLATE

Figs. I—4. *Podosporium thysanolaenae* (1) synnemata (semi-diagrammatic); (2) conidia; (3) germinating conidium and (4) conidiophore.



Non-Paraistic Stem Galls on Tobacco.— N. Prasad. While working with wilt of tobacco (*Nicotiana tabacum* L.), some peculiar outgrowths on the stem of a plant in a pot growing in the glass house were observed. The pot was infected with one of the strains of *Fusarium oxysporum* f. *nicotianeae*. From a distance, little difference could be observed between this and other plants in pots. This plant was only slightly stunted compared with others. Near the surface of the soil, peculiar outgrowths could be observed on the stem. This consisted mainly of protrusions on the stem which had a pale yellowish colour. From a distance the affected portion presented an appearance similar to blisters due to small pox (Fig.1). There were extremely large number of galls on the stem. These galls extended to about three inches on the stem above the surface of the soil. The plant was carefully pulled out from the pot and

Fig. 1.

thoroughly washed. Very few galls were found below the surface of the soil, and roots were practically free from them. Transverse and longitudinal sections were cut of the affected portions and were examined under the microscope. No fungi or bacteria could be traced in the affected tissues. Repeated isolations were made from the affected parts of the plant but any type of organism failed to develop. In the transverse section (Fig. 2), it can be readily seen, the outgrowths have arisen from the tissues of the plant. It is difficult to guess the exact cause of these galls on this plant. A search was also made for similar plants in the pot-house but no other specimen could be found. It is likely that these galls may be of non-parasitic origin. A review of relevant literature failed to reveal the existence of such galls on the stem of tobacco.

Fig. 2.

Mutation in Cucumis Virus 2C.— R. N. Azad. Mutations are known to occur in some plant viruses. McKinney (1926; 1929) was the first to observe and study the yellow spots developing on tobacco leaves infected with tobacco mosaic virus and also to suggest the possibility of mutation in the virus. Later on, he (1931) isolated a yellow mosaic from yellow spots developing on wheat plants infected with the ordinary mosaic virus. McKinney's discovery of mutation was followed by similar studies of Jensen, Kunkel, Holmes, Price, and other workers in a few different plant viruses. A similar case of mutation in another plant virus is reported here.

A new strain of *Cucumis* virus 2, responsible for mosaic disease of bottle-gourd (*Lagenaria siceraria* Standl.) and designated as *Cucumis* virus 2C, was reported by Vasudeva *et al* in 1949. While carrying out further investigations on the virus, spontaneous mutation in it was observed for the first time in infected bottle-gourd plants grown in a glass-house in the summer of 1952. Subsequently, similar cases of mutation were observed under natural conditions in the infected bottle-gourd crop grown in the experimental area.

The mutant arises in the form of distinct, yellowish, irregular spots of varying size and shape on bottle-gourd leaves infected with *Cucumis* virus 2C which is characterised by large pale or light green mottle with dark green blisters or green vein-banding and slight puckering of leaves. Plate I Fig. 1 shows typical symptoms of *Cucumis* virus 2C on bottle-gourd and fig. 2 shows the yellow mutant. It has been observed that the virus freely mutates under favourable environment; and during the summer months, i.e., when high temperature prevails, mutation occurs more frequently.

The mutant was isolated from the type strain by taking inoculum from the 'mutant spots' and making serial transfers till a pure culture was established, after the technique used by Salaman (1933) with potato virus X. Plate I fig. 3 shows concentration of the mutant strain during serial transfers and fig. 4 shows its typical symptoms on bottle-gourd. Plate II shows the range of symptoms produced by the mutant strain on bottle-gourd: figs. 1-3 show the primary symptoms which usually consist of intense vein-clearing and numerous yellowish spots scattered all over the leaf surface, whereas figs. 4–6 show the advanced symptoms developed as a result of systemic infection. The characteristic yellowish mottle induced by the mutant strain is generally accompanied by puckering of leaves. In advanced stages of infection the leaves are often malformed (fig. 6).

The culture of the mutant strain maintained on bottle-gourd plants has consistently exhibited its characteristic symptoms different from those of the type virus. Such permanent departure in the symptoms has been considered by McKinney (1935) to be the essential criterion for mutation.

Thermal-inactivation and dilution-end points, and longevity-*in-vitro* of the type virus and the mutant strain do not show any appreciable differences. There is, however, a marked difference between their virulence as indicated by the severity of symptoms produced on bottle-gourd and also on other differential hosts, viz., musk melon (*Cucumis melo* L.), 'kakri'

(*C. melo* var. *utilissimus* Duthie and Fuller), and snake-gourd (*Trichosanthes anguina* L.), the mutant being more virulent on all these hosts. Hutton and Peak (1951) have similarly observed that virulent mutant arises spontaneously in *Datura stramonium* infected with avirulent strains of potato virus X.

This is the first record of mutation in *Cucumis* virus 2C. Since the spontaneous mutation in the virus results in throwing off more virulent forms, further studies on the factors responsible for mutation; relationship between the mutant strains and the type virus; and behaviour of the mutants are in progress.

PLATE I

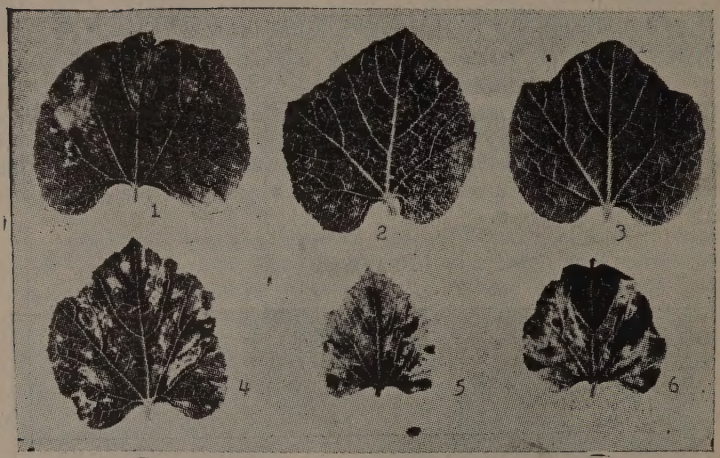
Fig. 1. Symptoms of Cucumis virus 2C on bottle-gourd.

Fig. 2. Appearance of mutant strain in the form of irregular yellowish spots on a bottle-gourd leaf infected with Cucumis virus 2C.

Fig. 3. Concentration of mutant strain during serial inoculations on bottle-gourd.

Fig. 4. Symptoms of the mutont strain od bottle.gourd.

PLATE II



Range of symptoms produced by the mutant strain on bottle-gourd; Figs. 1-3 show the primary symptoms and Figs. 4-6 show the advanced symptoms developed as a result of systemic infection.

Grateful thanks are due to Dr. R.S. Vasudeva, Head of the Division of Mycology and Plant Pathology for his guidance and helpful suggestions during the course of this investigation—Divison of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi.

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